

THE EFFECT OF AMATEUR RADIO ON STUDENT ACHIEVEMENT
IN A BEGINNING COLLEGE LEVEL ELECTRONICS COURSE

A Dissertation

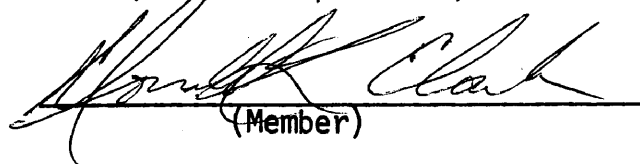
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ABSTRACT

The Effect Of Amateur Radio On Student Achievement
In A Beginning College Level Electronics Course (December, 1977)

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By reason of the apparent popularity of the use of amateur radio activities as motivational techniques among some educators, it became important to investigate the relationship of amateur radio activities to student achievement. Such an inquiry was appropriate as, unlike the motivational and instructional techniques of individualized instruction, listening instruction, and others, literature was not available which was addressed to the effect amateur radio activities have on student achievement. The purpose of this study was to determine whether student achievement in beginning college level electronics courses in which amateur radio activities were used as a motivational device was significantly different from student achievement in the same electronics course taught by conventional methods.

A research design was chosen which utilized two sections of the same electronics course: one section was an experimental group exposed to amateur radio activities, and the other was a control group not exposed to amateur radio. A test instrument was developed for the purpose of measuring the achievement of the students. The instrument was utilized as a pretest and as a posttest for both groups. The amateur radio activities included a movie, class discussions,

demonstrations of the "ham" station, a guest speaker, and student use of the amateur radio station for long distance communication. Student achievement was defined as the gain score between the pretest and posttest.

A statistical comparison of the pretest scores made by the experimental and control groups indicated that no significant differences in the amount of prior knowledge of the subject matter between the two groups were found. Based upon pretest and posttest scores, a statistical "t" test showed that both the experimental and control groups obtained significant achievement.

In order to examine objectively the extent of achievement of students in the experimental group relative to that of students in the control group, the following null hypothesis was tested: There is no significant difference in achievement between students enrolled in a beginning electronics course in which amateur radio activities are used as an instructional aid and students who take the same course without amateur radio activities. The statistical technique of analysis of covariance was used to test the hypothesis, and an insufficient value of the F statistic was obtained to reject the null hypothesis.

The conclusion was drawn that even though the experimental group did not have significantly greater achievement than did the control group, those students exposed to amateur radio activities did no worse. Thus the experimental and control methods appeared to be equally effective in promoting student achievement in the beginning electronics course.

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A special debt of gratitude is extended to my wife, Phyllis, for her special encouragement, patience, and support and especially for typing the dissertation.

DEDICATION

This dissertation is dedicated to

my wife Phyllis

and sons Scott and David

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CHAPTER I

INTRODUCTION

Making the teaching-learning process both enjoyable and profitable for the student is the desire of perhaps the majority of people engaged in the field of education. In pursuit of this objective, many educators through the years have proposed numerous and varied techniques and devices which would cause learning to be more interesting and the topics studied to have greater relevancy to that which the student perceives as important.

A significant goal of industrial education electronics programs is to relate the electronics industry to the students in the most meaningful fashion possible (Strong and Schaefer, 1975, p. 65).* One method which is used to make the subject relevant and meaningful to the student is the laboratory type of activity. Such activities allow students to gain experience in operating equipment, designing and constructing projects, connecting electrical components and circuits and taking measurements in order to demonstrate principles of operation and other situations, all of which are designed to stimulate learning. Several electronics teachers appear to have found amateur radio to be one such laboratory activity.

*The citations on this and the following pages are in the style of the Journal of Industrial Teacher Education.

Rationale

It would probably be idealistic and/or naive to believe that all college students are eager to obtain the knowledge which may be learned from every course they take and are willing to devote endless hours of concentrated study, in addition to the regularly assigned course work, to understand all aspects of the subject matter involved. Yet, this degree of motivation and effort may be exhibited by a few students in a course in which they possess a great deal of interest and consider the acquired knowledge as having value for them. This enthusiasm possibly could have been created by the teacher within the given course itself or perhaps was initially brought to the course by the student. However, perhaps too often, a student will enroll for a given course simply because the course is a requirement, and the attitude felt toward the course may be less than desired--possibly even very negative. If such an attitude persists, the effort a student extends toward the course may be just enough to obtain that particular final grade which he or she perceives as being necessary--whether it be an A or a D. At the completion of the course, the efforts of both the student and the teacher are reflected by fewer benefits to the student than would have been obtained if a more wholesome attitude had existed, and the time spent in the course could have been more enjoyable.

The realization that all students are not highly motivated in every course they take has led many educators to experiment with

various motivational devices designed to stimulate a desire to learn on the student's part. These motivational techniques vary widely and emphasize both class activities performed as a unit or individual student activity. A look at some reports of motivational techniques which educators have tried in the past gave insight into methods and techniques which could be employed.

In a study performed by Drummond and Vitro (1974), the value of motivation per se was made evident. Student learning was measured relative to varying degrees of motivation and different motivational techniques. This research indicated that as the degree of motivation was increased, more learning occurred. It was also shown that the amount of learning increased with an increase in student participation in the teaching-learning process. Since amateur radio could be classified as a student participation activity, it might be used to produce an increase in motivation and learning.

Other support for the use of a project to increase motivation came from Miller (1974) who based his belief on the fact that the project requires a high degree of individual participation and can be used to place technical subject matter into perspective. Thus the project was both a motivational device for students and an instructional tool for the teacher. Amateur radio seemed to fit into both these categories.

Amateur radio could be used as a class project at times during the projected research study, and support for the class project as a motivational device came from Markowitz (1974). He credited the

class project with creating greater interest in and a more desirable attitude toward the subject on the part of the students.

At times amateur radio activities became a game as students organized into teams which compared radio contacts made. The use of games to develop greater student enthusiasm for some students was reported by Root (1971) who found that games based on the subject matter are beneficial devices to increase both the desire to learn and the retention of course content. On a similar note, it was reported in the article, "A Sign That All Can Read" (Journal of Reading, 1972), that the competitive element itself is useful for motivating students.

It was evident from the literature available that motivation of students was desirable. Amateur radio activities as projected for use as a motivational device contained many of the same features which had been labeled advantageous in creating motivation for many of these prior studies on motivational techniques. Literature which dealt specifically with the use of amateur radio in education was sought.

As was true for the motivational techniques already listed, amateur radio was found to be of benefit to both educators and students. Educators recommend it for utilization in teaching course content and in exciting interest. Drummond and Vitro (1974) believe that the use of radio in teaching factual information is at least as effective as conventional methods of presentation and is better liked by students. In addition to their application as an

instructional aid in relating subject matter to students, amateur radio activities resemble other motivational techniques such as role playing, games, and other action or student involvement types of experiences because amateur radio contains an interest arousing element. In his study entitled "Amateur Radio Operation In Missouri And Its Implications For Industrial Arts Education," Hampton (1959) made an analysis of amateur radio operation and recommended the use of amateur radio activities to nurture and encourage interest in technical subjects.

Amateur radio activities are being employed by a growing number of educators. In the state of North Carolina, approximately one-half of the industrial education departments in the universities contain electronics laboratories which have been equipped with amateur radio stations within the past six years. The Federal Communications Commission (1974) reports a forty percent increase in the number of amateur radio stations in the United States from 1970 to 1973, a combined percentage which reflects growth in all categories of stations, including those stations in schools. For example, the increased number of stations in community and junior colleges has precipitated establishment of the National Junior College Amateur Radio Network, representing over one hundred active member stations throughout the United States (Schickman, 1974).

Since amateur radio activities were beginning to be found in increasing numbers in schools across the United States, educators

must have found them beneficial in the learning process. All devices employed in schools for the purpose of motivating students toward increased learning should be tested as to their effectiveness, and information should be obtained which would allow educators opportunity for comparison of methods. Data similar to that existing on several other motivational devices and relative to the effectiveness of amateur radio activities on student motivation was needed.

Statement of the Problem

In view of the apparent popularity of the use of amateur radio activities as motivational techniques among some educators, there was a need to investigate the relationship of amateur radio activities to student achievement. The problem of determining what benefits, if any, amateur radio activities might have on student achievement needed resolving. Such an inquiry was appropriate as, unlike the motivational techniques of individualized instruction, role playing, and others, literature was not available which was addressed to the effect amateur radio activities have on student achievement. Much time, effort, and money may be spent toward the establishment of an amateur radio station in an industrial education electronics laboratory; thus, it would be advantageous for educators to know of any benefits relative to student achievement which amateur radio activities might provide, prior to the expenditure of their resources.

Purpose of the Study

The purpose of this study was to determine whether student achievement in beginning college level electronics courses in which amateur radio activities were used as a motivational device was significantly different than student achievement in the same electronics course taught by conventional methods.

Assumptions

For the purposes of this study, the following assumptions were made:

1. In terms of controlled variables, both the experimental and control groups were homogeneous. This assumption was based upon the fact that enrollment for both groups was taken from the same population--sophomores, juniors, and seniors majoring in industrial education.
2. Uncontrolled variables, such as the time of day the class met, had little or no consequence on the outcome of the research. This assumption was based upon research which revealed no significant differences in achievement between classes taught at the following times: 9:00 A.M., 11:00 A.M., 1:00 P.M., and 2:00 P.M. (Lacroix, 1971).
3. Student achievement in a beginning electronics course was adequately measured by the use of an achievement test.
4. The Hawthorne effect (Ary, Jacobs, and Razavich, 1972, p. 226) had an insignificant bearing on the results of the study.

5. Time which members of the experimental class voluntarily spent using the amateur radio station outside of the class period had a negligible effect on the results of the study.
6. Instructor bias had an insignificant effect on the outcome of the research.

Null Hypothesis

Differences in overall achievement between students in the experimental class and control class were determined by testing the following null hypothesis: There is no significant difference in achievement between students enrolled in a beginning electronics course in which amateur radio activities are used as an instructional aid and students who take the same course without amateur radio activities.

Definition of Terms

The following definitions are given for the purpose of clarifying technical terms which appear in this research report.

Amateur Radio: A "scientific hobby, a means of gaining personal skill in the fascinating art of electronics, and an opportunity to communicate with fellow citizens by private shortwave radio (The American Radio Relay League, 1975, p. 7). "

Amateur Radio Operator: "A person licensed to operate radio transmitters as a hobby (Graf, 1972, p. 24)."

Amateur Radio Station: "A radio transmitting station operated by one or more licensed amateur operators (Graf, 1972, p. 24)."

Continuous-wave (CW): "Electromagnetic waves generated as a continuous train of identical oscillations. They can be interrupted according to a code (Graf, 1972, p. 120)."

Electronics: "Pertaining to that branch of science which deals with the motion, emission, and behavior of currents of free electrons, especially in vacuum, gas, or phototubes and special conductors or semiconductors (Graf, 1972, p. 189)."

Ham: "The slang term for a radio amateur or experimenter (Gerrish, 1970, p. 48)."

Receiver: "A device for the reception and, if necessary, demodulation of electronic signals (Funk and Wagnells, 1969, p. 132)."

Single-sideband: "A type of radio telephone service in which one set of sidebands (either upper or lower) is completely suppressed and the transmitted carrier is partially suppressed (Graf, 1972, p. 537)."

Transceiver: "A unit that combines the functions of a radio transmitter and a radio receiver, generally having some of its components common to both operating modes (Funk and Wagnells, 1969, p. 132)."

Transmitter: "Equipment used to generate and amplify a radio frequency carrier signal, modulate this carrier with intelligence, and radiate the modulated radio frequency carrier into space (Graf, 1972, p. 617)."

Limitations

The following limitations were present for the purpose of research control of sample size and class size:

1. The sample was composed of only those students enrolled in the beginning electronics course in the Department of Industrial and Technical Education at East Carolina University during the 1976 spring quarter.
2. Individual class size was limited to no more than sixteen students because of facility limitations.

Summary

This study dealt with relating student achievement in college level electronics courses to amateur radio activities. The need for the research was prompted by the large number of amateur radio stations contained in schools and the lack of previous research addressed to the effect such amateur radio activities might have on student achievement. Much time, effort, and money may be spent toward the establishment of an amateur radio station in an industrial education electronics laboratory; thus, it would be advantageous for educators to know any benefits relative to student achievement which amateur radio activities might provide prior to the expenditure of their resources. The purpose of this research project was to provide data which showed the effect amateur radio activities would have on student achievement in a college level beginning electronics course.

Assumptions, hypotheses, and limitations of the research were delineated in this chapter, and major terms used in the study which are common to the field of electronics and amateur radio were defined.

CHAPTER II

REVIEW OF THE LITERATURE

After an initial cursory review of the literature related to amateur radio, it was evident to the researcher that a study to determine the effects of amateur radio on student achievement was needed. A review of related literature was conducted, focusing primarily on literature concerning either teaching techniques, motivation, or amateur radio. Motivation was explored to determine benefits which could accrue from it, factors which affect it, and devices or activities which have been used to motivate. Amateur radio in education was the subject of several articles, but only one research project was identified that dealt directly with the topic. In this chapter ideas and opinions which are pertinent to teaching techniques, motivation, and to the application of amateur radio activities as a motivational device are discussed, and the one research project concerning amateur radio is reviewed. An extensive search of possible sources of information related to the objectives of this research was made.

Related Research

It was determined from a study of numerous sources that motivation is regarded as important in education as well as in other areas. One motivation specialist (Van Derbur, 1974) stated that ". . . the greatest need in education today is student motivation (p. 70)." In a study concerned with industry, Edward M. Glasner (1973) stressed the direct relationship of worker motivation to work attendance and

productivity and cited case histories of companies which were successful in improving productivity, reducing absenteeism, and reducing turnover by creating a better working atmosphere. The source of motivation was examined by Root (1974) who concluded that a student is motivated by the ". . . likelihood that he can get something he personally values as a result of his own actions (p. 395)." He further stated that motivation is learned.

Drummond and Vitro (1974) qualified their views of motivation by stating that ". . . learning increases with increased motivation up to a point (p. 30)." However, too much motivation would not necessarily mean more learning. They also supported a large degree of participation by the student if learning was to be effective. In this vein, radio as an instructional tool was found to be at least as effective as conventional teaching methods in teaching factual information according to these authors.

Educational research projects which were analagous in some respects to this project concerning amateur radio as a motivational device were also investigated. One of these, a research to determine ". . . the extent to which achievement motivation is predictive of diagnostic problem solving effectiveness" was conducted by Donald J. Stephenson (1971, p. 32). Using auto mechanics students at Indiana State University, Stephenson grouped the students in terms of achievement and test anxiety and then presented three problem solving activities. He found that achievement but not attitude was predictive of diagnostic problem solving effectiveness. A contrary conclusion

was found by Joel C. Tate (1972) in a similar research project. Using a social science course at the community college level, he concluded that academic motivation when measured and used as a predictor of grades has a significant positive correlation with grades earned.

Other motivational factors were investigated by Frank M. Pittman (1970) to define the relationship of achievement in beginning college level courses in woods, metals, and electricity/electronics to various mechanical aptitude tests, the number of high school credits for math, science, or industrial arts, and the students' home environments. Using data obtained through student questionnaires and standardized tests as the independent variable and the final grade earned in the woods, metals, or electricity/electronics classes as the dependent variable, Pittman concluded all factors combined were predictive of achievement in electricity/electronics but not in woods or metals, although individual factors were found to predict success in those areas.

Two authors attested to the importance of motivation in a study of school dropouts. Jared V. Terry (1972) concluded after in depth interviews with college dropouts that the absence of positive motivation for achievement contributed to failure in academic programs. Similarly, Norman C. Pendered (1970) noted the need for wholesome atmospheres in schools and feelings of success on the part of the student. Thus, from the positive standpoint of the previous articles, motivation was seen as important in achieving positive results.

An investigation of the factors affecting motivation revealed diverse and imaginative ideas, many of which related to this research project. In Exemplars of Teaching Method, Broudy and Palmer (1965) suggested that children be taught by ". . . play and pleasure . . . " rather than by ". . . compulsion and fear . . . (p. 83)." Among their methods of motivation were pistol firing, games, and bribery (prizes, grades, and the like). Broudy and Palmer concluded that a cheerful atmosphere increases learning. Individual differences were noted as important by Carl Gregory (1969) who referred to different time cycles of creative output for each student. For this reason he advocated flexible working hours in laboratories. He also stated that objectives which are definite and clear are important to motivation.

In much the same way that amateur radio would be used to motivate beginning electronics students, areas of interest such as electronics were used to make mathematics more relevant in a study performed by Harry Ellis and Joseph F. Payez (1974). They found that using interest areas increased motivation, decreased dropouts, and shortened learning periods for various mathematical topics. Relevance of subject matter was also found to be important in a 1969 study by John M. Peters. Using prison inmates who had been given information concerning parole at varying times during their incarceration, Peters conducted a study which showed with a high degree of confidence that the more relevant the information studied is perceived to be by the student, the greater the motivation to study the material.

A study conducted by Mildred E. Hight (1973) sought to identify factors which could improve achievement of vocational education students and to investigate intrinsic and extrinsic motivational characteristics as they related to individual performance. Using pretests and posttests to obtain her data, Hight discovered no significant difference between motivational attributes of individuals and their performance but did find a highly significant positive relationship between intelligence and performance. A related study by Kesselman in 1975 used money as a reward for both the experimental and control groups. The study indicated that intrinsic motivation to solve problems was not significantly influenced by money.

Several factors affecting adult learning as specified by recent research were summarized by Curtis G. Larson in the American Vocational Journal (1970). According to Larson, adults have been found to be motivated by economic factors and by the drive to self-actualization. Larson also noted that research has shown motivation to be greatest in low anxiety atmospheres where satisfaction occurred during the learning process. Similarly, James A. Dent (1972) identified factors such as self-satisfaction, security, and success as primary incentives for students selecting a particular program in vocational education. Students were least motivated by counselors in this research project.

Lorenzen's dissertation research (1974) employed a survey to analyze facts and opinions of vocational-industrial teachers

regarding forces and elements affecting professional development. Lorenzen found that those individuals surveyed were motivated by financial benefits, a felt need for additional training, and vocational teacher certification requirements. The attitudes of instructors of high and low achievers (as rated by class achievement scores) were examined by Spaulding (1971). He concluded that instructors' educational, technical, teaching, and sociocultural backgrounds as well as their personal attitudes were not significant in predicting the achievement of their students.

After the various benefits of motivation and the numerous factors which either did or did not influence motivation were surveyed, attention was given to instructional devices and procedures related to student motivation and/or academic achievement. These devices and procedures found in the literature were diverse. Several of these procedures could be classified as teaching methods.

In a study of three classes of ten students, Steve Phillips, Jr. (1972) found that a taped lecture with visual aids was significantly superior in terms of student achievement to taped lectures with no visual aids and to a handout method of presentation. Thorn and Bundy (1969) experimented with television instruction for electricity/electronics students in the casual setting of the instructor's office and determined that learning was as great as by conventional classroom methods. The television presentation incorporated slides and audio-visual material.

Roy D. Brown (1970) described a study involving students enrolled under the Manpower Development Training Act. The device used in the study to create a desire to learn was the removal of the students' excuses for not being more productive and the replacement of these excuses with questions and answers designed to guide the student to the understanding that his low status in life was due solely to himself and his lack of marketable skills. Once this realization was made, students were more interested in learning. Richard A. Lyons (1969) determined that students were not significantly motivated to greater achievement by the administering of conceptually and non-conceptually oriented tests. The experiment was conducted on a control and experimental group of basic electronics students in college. Another doctoral experiment by Foster A. Stanfield (1971) concluded that assigning drafting problems related to student interest did not produce a significantly higher difference in learning or retention. Student learning has also been discovered to be directly related to a student's listening ability. Research conducted by Broadhurst (1969) showed that achievement of those students enrolled in a college level beginning drafting class in which specific instruction was given regarding how to listen was significantly greater than student achievement in a control class where no such instruction was provided.

Research by Reeser (1971) showed that slide-tape presentations were more effective than the individual booklet method or the teacher lecture method in obtaining student achievement. Donald M.

Edwards (1974) found the audio-tutorial method of teaching to be effective in stimulating achievement. Learning activity packets designed to provide enjoyable and meaningful learning experiences in order to improve student motivation in electronics were described by Jelden in Man/Society/Technology (1972). The students were taught via the packet the importance of learning a given topic and the relevance of the topic to areas of knowledge with which the student was familiar. Danny J. Simmons (1973) reported that students with low motivation scores on the college guidance and placement tests performed satisfactorily in an electrical technology program taught by multi-media individualized instruction. Simmons stated that this multi-media approach ". . . provided a vehicle for the motivation of students lacking positive self-image and confidence to receive motivation in their pursuit of learning by allowing them the right to learn at their own speed (p. 1)."

Self-paced instruction was also responsible for significantly higher achievement for experimental class students in a digital systems engineering course (Roth, 1973). Another study involving electrical engineering students pointed out that lectures interspersed with short quizzes and solutions resulted in higher grades and more favorable attitudes for the students than did conventional lectures with tests administered only at the completion of a unit (Cleaver, 1976).

A research project by Lacroix (1971) produced two conclusions relative to academic motivation. First, the study showed that the

time a course was taught had no significant impact on student achievement. Second, the control group taught by lecture methods for four meetings a week performed significantly better on achievement tests than did experimental groups, one of which was taught by lecture for three meetings a week and the other taught by individualized instruction and one meeting a week. Lacroix stated that one of his objectives in the study was to determine if college students were sufficiently self-motivated to learn on their own through the individualized instructional techniques. He concluded that such motivation did not exist in those students studied. Motivation by means of self-paced methods of instruction was advocated by Flammer and Mecham (1974). They cited such factors as greater student involvement and more relevance as contributing to improved motivation when self-paced methods are employed. Memmott (1962) experimented with timed individualized instruction and found that average and high achievers performed better under this method than did low achievers. Rosin (1969) concluded that students in classes lasting for only two hours performed as well as students in the traditional three hour vocational classes.

Another technique utilized to improve student interest in subject matter is the use of case studies. Case studies perhaps would not lend themselves for use in all curricula, but Smith (1975) pointed out that theory is better understood by most people after seeing examples of application. Smith further noted that the integration of case studies into a course arouses interest and contributes toward higher achievement. This use of case studies was also

advocated by Fuchs (1974) who suggested using case histories as a motivating technique. He noted that these histories could be used to show the relevance of course work and to point out mistakes or means of improvement for the individual involved in the case history.

Cooperative education was the subject of a study performed in five community colleges in California (U.S. Department of Health, Education, and Welfare, 1973). Data was obtained in sixteen areas of study over a three year period of time, and achievement of cooperative education students was compared to that of all students. The research indicated that, in those courses which were required of all students, student retention of the subject matter was doubled and the drop-out rate reduced among the cooperative education students as compared to all other students. The increased student performance was regarded as being the result of experiences gained through cooperative education. Seaverns (1970) also investigated cooperative education which integrated classroom study with supervised learning experiences outside the classroom. Seaverns noted that cooperative education has a positive effect on academic motivation. He states, "The integration of work and study increases student motivation because it engenders a stronger desire to learn (p. 11)."

In addition to the numerous teaching methods which have produced positive results in the classroom, many activities which could be used periodically in the classroom were found in motivation related literature. Fuchs (1974) who, as previously reported, advocated case histories, also recommended the use of role playing to involve and

motivate students. Games designed to teach the subject matter were suggested by Gus Root (1971) as a motivating device.

Gordon H. Flammer (1972) supported the use of these devices of case studies, role playing, and games and also recommended student independent work and student team work for motivating students. Homework was studied by Mancil W. Milligan and Robert L. Reid (1973) who found no significant difference in achievement between students whose work was graded and discussed in entirety and those whose work was done and discussed at the discretion of the teacher.

In a paper presented at the Annual Meeting of the American Society for Engineering Education, Nachtigal (1975) subscribed to the motivational value of the individual student project. Nachtigal used the project as a student activity in a laboratory course in systems and measurements. Students built measuring systems from blocks of circuitry and then interconnected the blocks to develop the required instruments as an alternative to using commercially produced instruments. Nachtigal noted that the project approach improved student interest in instrumentation and was a stimulant to learning because the projects showed the students what was actually occurring inside the equipment. Beakley and Chilton (1972) also suggested the use of projects--especially mini projects which would apply to a day's lesson or to a complete unit. They found that students involved in the projects performed better on achievement tests than students not involved.

Many authors have attested to the value of motivation toward achievement both in and out of the educational setting. It is a factor with which educators and industrialists are concerned, the former with its effects on learning and the latter with the influence motivation has on job performance. Academic success and motivation have been directly related in the literature, many factors which affect motivation have been reported, and numerous teaching methods and activities related to academic achievement and motivation have been surveyed. Several of these techniques share common characteristics such as involving students in an activity, designing and/or building projects, increasing relevance of subject matter, and making learning more enjoyable. Most of these characteristics are also found in many activities of amateur radio. Amateur radio activities have interest attracting capabilities, allow for individual and group involvement, and may have potential instructional value for increasing meaning and importance of certain subjects. Therefore, the use of amateur radio activities as an instructional and motivational technique might assist students to greater learning just as some of the reported techniques produced positive results.

Amateur Radio Activities in Education

The utilization of amateur radio activities by teachers can be found in most levels of education from elementary school through college. Just as many have found another given motivational or instructional technique of value, so have educators who have

utilized amateur radio activities found positive effects of these activities on student motivation and achievement. Those educators using amateur radio activities view them as being advantageous in attracting students' attention, creating interest, developing an atmosphere conducive to learning, and enhancing the relevance of certain subjects to students by providing examples of practical applications. Amateur radio has been used as a motivational device, an instructional tool for teaching subject matter, and as a public relations device for some educational programs. In the following paragraphs, specific examples of amateur radio activities as applied to education are reported.

Amateur radio activities have been considered to have value in enhancing student motivation in various fields of study. Wood (1970) reported the use of such activities in elementary school as an interest developing device in units of science and geography. He found that certain units of study in general science could be more interestingly taught and the material made more relevant to the students through amateur radio activities. Such units were concerned with the layers of the atmosphere, frequency, and radio waves. Amateur radio was of benefit in Wood's teaching of geography in that when a given area of the world was studied, students were provided with an opportunity to talk with a radio amateur who lived in that country. In this way students could have received information related to their study on a personal basis. As a result of this first-hand experience, students could better identify with that country and were

more highly motivated to study about it than would have been the case without the activities provided through amateur radio. Wood noted that he no longer had a problem with student motivation because as he stated, ". . . the radio did it for me (p. 118)."

Although Wood's beliefs regarding the benefits of amateur radio as a motivational device for certain units of general science and geography were founded upon personal observation rather than objective research data, research by Cattell (1974) has shown that a significant direct relationship existed between student motivation and academic achievement in the areas of science, social science, reading, and mathematics. It would appear that if Wood's students demonstrated greater interest, then perhaps this resulted in more learning.

Further indication of the relationship between understanding of science and involvement in amateur radio activities is noted in the application of amateur radio as demonstration equipment in the study of radio waves. Reiley (1974) related that the "ham" station was used to demonstrate principles of and create interest in the field of science among the public, and he stated, "The experience at the Hall of Science has proved once again the great value of amateur radio in motivating people to a better understanding of science (p. 95)." Reiley's reported involvement with amateur radio and the public suggests that people are curious about and attracted to demonstrations of amateur radio activities, and through this interest they become more susceptible to interest in related topics.

Many students across the United States have been exposed to amateur radio activities in various ways. In Meeker, Colorado, a high school has an amateur radio facility which may be enjoyed by all students (Clark, 1969). One member of the staff, a licensed radio amateur, operates the station, and schedules were established which allowed for individual students, teachers, and classes to utilize the station in relation to their studies. The amateur radio activities were applied as a demonstration device for certain principles studied in science and as a means of providing for actual conversations with Frenchmen for the French foreign language students.

The opportunity offered to students of one class talking to members of a similar class located elsewhere in the world is one of the educational benefits of amateur radio activities discussed by Giese (1955). He noted that motivational gains could result from such conversations in not only foreign language classes but in other classes as well. This type of activity is a regular occurrence at the junior college level and is so widespread that several junior and community colleges have organized their individual amateur radio clubs into the National Junior College Amateur Radio Network (Schickman, 1974). The network broadcasts each Thursday during the months of September through April.

In addition to its instructional value for certain classes within the school, amateur radio has appeared beneficial in establishing favorable community public relations for some science or electronics programs through the involvement of local radio amateurs in the

curriculum. Dirrigl (1975) described classroom demonstrations showing principles of satellite communications which included radio amateurs from the community bringing their equipment into the classroom and performing global communications via one of the amateur radio satellites (OSCAR). OSCAR is an acronym for Orbital Satellite Carrying Amateur Radio. The demonstrations also showed the principles of satellite tracking and course plotting. The OSCAR project was a joint effort among the National Aeronautics and Space Administration and national amateur radio organizations throughout the world such as the American Radio Relay League (Curtis, 1976). According to Gorski (1975), the OSCAR program has helped bring community members who are radio amateurs into the schools at all grade levels, thereby furthering positive relationships between the school and community and simultaneously allowing for greater personal awareness and understanding of space science among students.

Although good community public relations may result from certain amateur radio activities, Smith (1956) noted that when amateur radio demonstrations are given in classrooms or school assemblies, student interest can be promoted in subjects such as science and electricity/electronics. Such activities not only advertise the related subjects but also show them to be interesting and informative.

Pautler (1962) suggested that in addition to being a good public relations device for educational programs, amateur radio activities can also help achieve objectives germane to industrial education. Such objectives could be assisting students to make

career choices and to cultivate avocational pursuits as noted by Wilber and Pendered (1967) or, according to Roberts (1965), to prepare students to enter the technical trades. The relationship which amateur radio activities might have to the selection of and preparation for a given career is indicated by Rippey (1952) who noted that one advantage of the use of amateur radio activities at the junior and senior high school levels is its ability to stimulate career thinking among the students. This is possibly due to the fact that the topic of many conversations among radio amateurs is concerned with an individual's job--the preparation requirements, duties, hours worked, pay, and the like.

Perhaps amateur radio activities could be applied in many areas of industrial education as an instructional and/or a motivational technique for career related information, but it would appear that these activities would be most nearly suited to the areas of electricity/electronics. It is believed by some authors that amateur radio activities belong in the electricity/electronics programs. Hage (1961) has stated, "The industrial arts program of a school becomes the natural place to foster amateur radio and conversely, amateur radio can foster the radio, electric, or electronics programs of industrial arts (p. 37)." Hage further observed the motivational characteristics of amateur radio activities by discussing the fact that the theoretical aspects of electronics might appear to be unimportant and abstract to a student who could then become discouraged in his study of the field. Hage indicated that through a student's

involvement with amateur radio, he or she can find relevance to and see the importance of the electronic theory.

Other authors concur with Hage's view regarding the benefits of amateur radio activities in electricity/electronics instruction. In an article which discussed the worth of amateur radio activities in schools, Pautler (1962) stated, "It is the author's belief that there is a real need for such a program in senior high electrical programs (p. 33)." During an October 17, 1975, interview, Dr. Isaac P. Hampton, Jr., author of the study entitled "Amateur Radio Operation In Missouri And Its Implication For Industrial Arts Education," stated that as a result of his many years of teaching electronics at various educational levels and as a "ham" operator, he regarded ". . . amateur radio as a motivational device of considerable force in creating interest in electricity and electronics." Weger (1960) supported the viewpoint that amateur radio activities are an asset in developing student understanding in the field of electronics, but he further regarded these activities as providing for the students a good avocational outlet--one which was directly related to their studies. It was indicated that adopting amateur radio as a hobby acts as a stimulus for further study in the area of electronics.

Amateur radio activities have been employed in applications other than as a motivational device or an instructional aid to demonstrate some theoretical principle. In a speech delivered to the American Industrial Arts Association, Dr. Donald Maley (1970) stated, "A broad range of instructional media is applicable. . . (p. 154)" for

industrial arts in the senior high school. It is in this context of utilizing multiple media techniques of teaching that amateur radio activities have been employed. Spatafora (1974) supported such use of amateur radio activities by suggesting that such activities help toward "media-izing" (p. 50) the classroom as an alternate approach to learning and allowing for variety in the classroom.

Despite the fact that the importance of amateur radio activities in the classroom has been recognized by several authors as noted in the preceding paragraphs, only one study directly involving amateur radio was found. This study, a doctoral research project entitled "Amateur Radio Operation In Missouri, And Its Implications For Industrial Arts Education," was written by Dr. Isaac P. Hampton, Jr. and will be reviewed in depth in the following paragraphs.

According to Hampton (1959), his research was to ". . . ascertain important experiences, viewpoints, and activities concerning the hobby of amateur radio as it is engaged in by Missouri residents (p. 1)." Specifically, this study addressed the following questions:

1. What is the age, sex, education, income and occupation of the hobbyist; how long has he had this hobby, and how much time and money is spent in its pursuit?
2. In what phases of amateur radio operation does the hobbyist participate; and how was interest in this avocation first developed?

3. What special equipment is used in connection with carrying on amateur radio operation as a leisure time activity, and was this equipment home-built or purchased ready made?
4. What sources of information and assistance have been of most benefit in making amateur radio operation a successful and rewarding hobby?
5. What are the curricular implications of amateur radio operation for Industrial Arts and Adult Education programs in Missouri? (Hampton, 1959, p. 1)

The investigation by Hampton was limited to the state of Missouri, and systematic sample selection was performed by selecting every fourth radio amateur residing in Missouri as listed in the 1958 edition of the Radio Amateur Callbook Magazine. A survey form was mailed to each of the one thousand amateurs comprising the sample with approximately fifty-five percent of the sample returning the questionnaire. Findings showed the average age of the radio amateur in Missouri to be thirty-five years with ninety-eight percent being male and either a professional person, technician, or student. Hampton found that most hams bought their receivers but built the transmitters and spent between one and four hours weekly on their hobby which cost an average of \$650.00 initially and \$100.00 annually. It was discovered that most radio amateurs had more education, greater reading ability, and higher income than the average United States citizen.

Four of Hampton's five recommendations advocated the employment of amateur radio operation in education and are listed below:

Interest in technical subjects can often be nurtured and encouraged in young people through the medium of hobby experiences; therefore schools should continue to encourage interest in scientific hobbies

[Schools should enlist the] . . . services of experienced radio amateurs as instructors and consultants for Industrial Arts and adult evening programs concerned with electronics.

Space should be provided by the school for radio club meetings, code practice sessions

Whenever possible, the schools should cooperate with other agencies promoting interest in electronics and communication through Amateur Radio (1959, p. 103).

Although encouraging increased use of amateur radio activities by the schools, Dr. Hampton's investigation was chiefly an analysis of amateur radio operation in Missouri and was not primarily concerned with applications of amateur radio in the field of education. However, his recommendations clearly stated the value of amateur radio in education.

It has become apparent that the use of amateur radio activities as an instructional aid and as a motivational technique was thought by some practitioners to be of value in the electrical and electronics programs of industrial education. It perhaps should be noted that no literature was found which contradicted

these reported viewpoints regarding the relationship of amateur radio activities to industrial education.

Description of Amateur Radio

Amateur radio may be defined as ". . . a scientific hobby, a means of gaining personal skill in the fascinating art of electronics and an opportunity to communicate with fellow citizens by private short-wave radio (The American Radio Relay League, 1975, p. 7)." The origin of amateur radio is so closely integrated with the development of early radio technology that a specific year cannot be stated as the beginning of the hobby; however, the turn of the century era between the late 1890's and early 1900's is considered the time of debut for amateur radio (DeSoto, 1936, p. 10). There were approximately one hundred and fifty radio amateurs in the United States in 1905 (DeSoto, 1936, p. 24). The first organization for amateur radio, the Junior Wireless Club, Limited, of New York City was begun by a group of boys approximately twelve years old in January, 1909 (DeSoto, 1936, p. 24). The association which was to become the major fraternity for amateur radio, The American Radio Relay League, was established in 1914 (DeSoto, 1936, p. 40), and the League's journal, QST, began publication in 1915 (Young, 1954, p. 42).

Today there are over 279,000 radio amateurs in the United States and 252,000 in other countries (Callbook, 1976, pp. 10 & 25).

Dannals (1972, p. 11) reports a growth of approximately 20,000 newly licensed radio amateurs per year. The Houston Chronicle (1976, p. 1) reports that the great popularity of citizen band radio is causing a rise in interest in amateur radio in that a large number of citizen band radio operators have taken or are preparing to take examinations for amateur radio licenses.

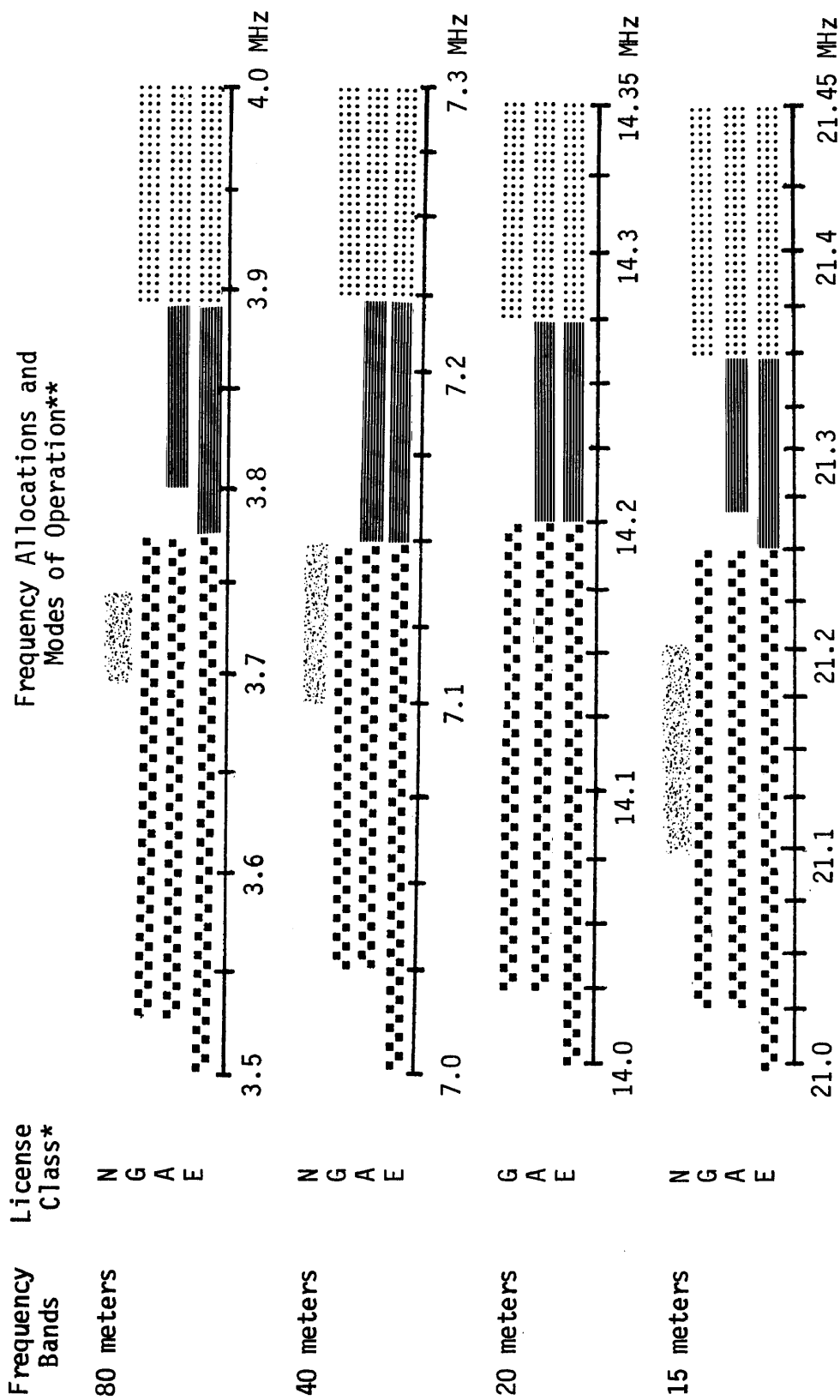
In addition to its use as a hobby, amateur radio also serves to advance the development of radio technology and to provide public service communications (Federal Communications Commission, 1974, p. 149). In order to obtain a license to operate an amateur radio station, an applicant must demonstrate ability in technical radio knowledge, code proficiency, and familiarity with federal regulations (The American Radio Relay League, 1976, p. 4).

Thousands of radio amateurs are members of organized public service systems. Perhaps the oldest such group is the Military Affiliate Radio Systems (MARS) established in 1925 ". . . to provide auxiliary communications to the military, assist in effecting normal communications under emergency conditions, handle morale and quasi-official record and voice communication traffic for Armed Forces and authorized civilian personnel world wide (Griffis, 1975, p. 52)." Other organizations include the Amateur Radio Public Service Corps, Radio Amateur Civil Emergency Services and the National Traffic System (The American Radio Relay League, 1975, p. 9). An example of public service communications is that performed by radio amateurs

operating in the National Traffic System who have arranged for over seventy-five hundred corneas to be transferred from the eye bank centers to people needing the corneas (Brier, 1976, p. 95).

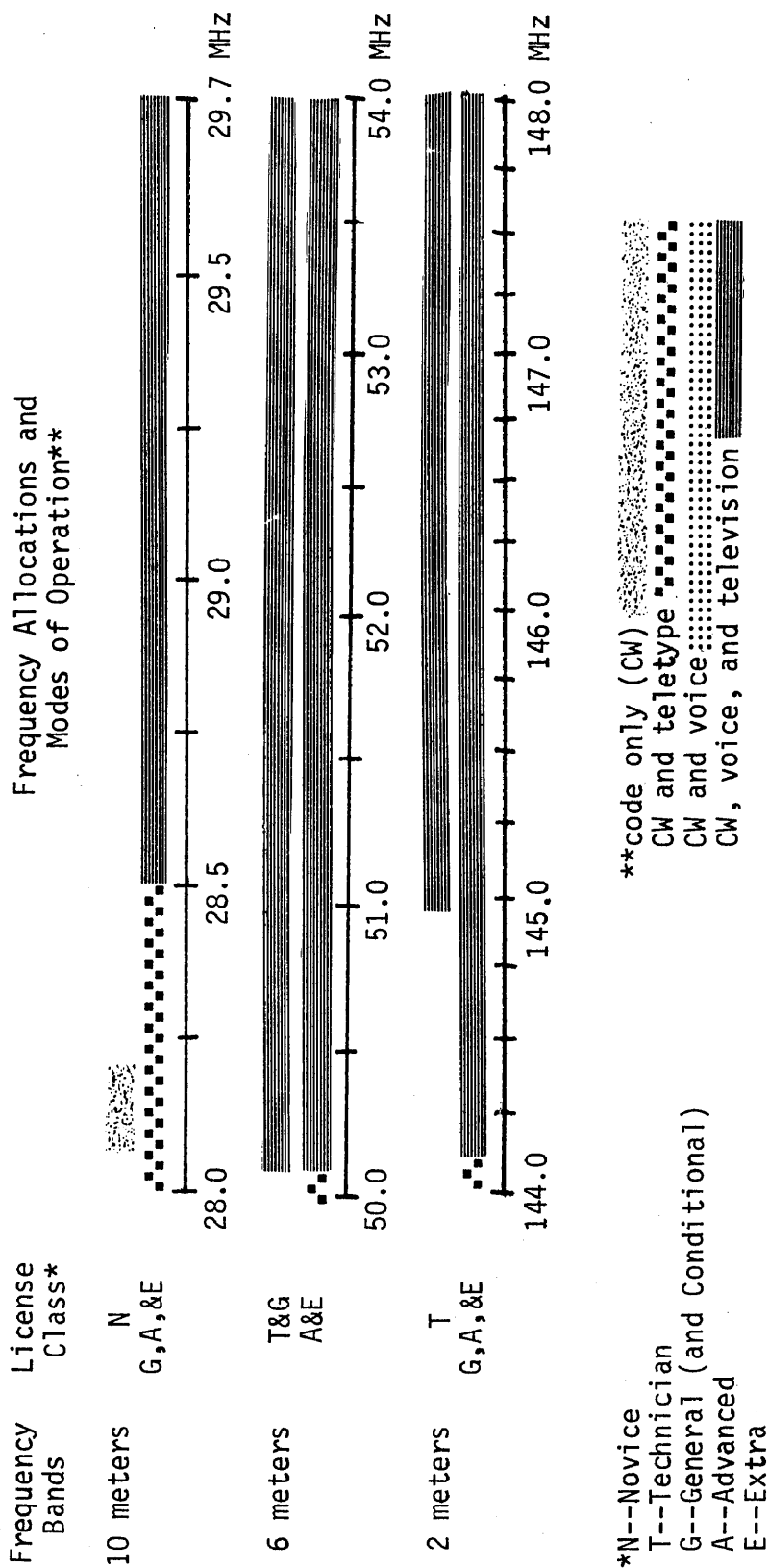
Depending upon the type of license held, a radio amateur may operate his transmitter and receiver on any one of several frequency ranges from 1.8 Megahertz (1,800,000 Hz) to 148 Megahertz with additional frequencies being shared with the government Radio Positioning Service (The American Radio Relay League, 1975, p. 14). Modes of operation allowed are also determined by the license held, but they include communication via radio telegraph, facsimile, radio teletype, slow scan television, and voice (The American Radio Relay League, 1972, p. 147). Figure 1 (p. 36) provides a summary of frequencies and modes of operation available to given licenses. Voice communication can be carried out through the use of one of three methods--amplitude modulated carrier (AM), frequency modulated carrier (FM), and single-sideband (SSB) (The American Radio Relay League, 1972, p. 147). The maximum power allowed an amateur radio operator is one thousand watts peak power delivered to the final amplifier stage of the transmitter (The American Radio Relay League, 1976, p. 43).

In order to own and operate an amateur radio station in the United States, it is necessary to hold two licenses, an operator's license and a station license, both of which are issued by the Federal Communications Commission. There are six classes of licenses issued



Amateur Radio Frequency Allocations

Figure 1



Note: The 160 meter band (1.8 to 2.0 MHz) is shared with Loran.

Source: The American Radio Relay League, 1976, p. 4.

Figure 1 (continued)

to radio amateurs--novice, technician, conditional, general, advanced, and the amateur extra. There is no age limit or prior experience required to obtain a license, but an applicant must pass a radio telegraph code test, both sending and receiving, and an electronic theory and regulations examination (The American Radio Relay League, 1976, p. 4). The requirements, privileges, and time duration of all classes of amateur radio operator licenses are included in Table 1 (p. 39).

Summary

Motivation was held to be a major factor in both academic and industrial achievement. Authors held varying ideas as to the benefits and factors affecting motivation, and numerous teaching methods, devices, and activities which could spur motivation have been tried. Amateur radio activities were noted by several authors as having been employed as motivational devices in the classroom. Such activities have been employed in a number of disciplines and at most grade levels, and in all reported cases, the teachers who used amateur radio activities in instruction were enthusiastic and complimentary about the benefits of student involvement with amateur radio. Both an increase in student motivation and greater understanding of certain subject matter were indicated as the results of using amateur radio activities in instruction.

TABLE 1

AMATEUR OPERATOR LICENSES

Class	Code Test	Written Examination	Term
Novice	5 wpm*	Elementary theory and regulations	Two years, not renewable
Technician	5 wpm	General theory and regulations	Five years, renewable
General and Conditional**	13 wpm	General theory and regulations	Five years, renewable
Advanced	13 wpm	General theory and regulations plus intermediate theory	Five years, renewable
Extra	20 wpm	General theory and regulations, intermediate theory, and advanced techniques	Five years, renewable

*words per minute

**The Conditional license is the same as the General license, except the examination for the Conditional class is taken by mail.

Dr. Isaac P. Hampton, Jr. (1959) conducted the only reported research on amateur radio, and his study analyzed amateur radio operation in Missouri with implications for industrial education. He gathered information as to the socio-economic characteristics of Missouri radio amateurs, types and costs of equipment used, and amateur radio operation data. Dr. Hampton found the typical radio amateur to have above average socio-economic standing and to favor the teaching of subjects relating to electronics in the schools.

Amateur radio began near the turn of the twentieth century and has grown to be a hobby enjoyed by over 500,000 people world wide. Many radio amateurs use their time and equipment for public service types of communications. In order to use the many frequencies and modes of operation available to radio amateurs, a person must pass certain examinations to qualify for the variety of amateur radio licenses available from the Federal Communications Commission.

The literature revealed that amateur radio activities are applicable toward achievement of objectives in industrial education electronics programs and also the motivation of students within such programs. Despite the dearth of research directly related to amateur radio and academic achievement, there is ample evidence from related literature that amateur radio could perhaps be a significant factor in industrial education electronics programs.

CHAPTER III

METHODOLOGY

Topics in this chapter include a description of the research design and manner of execution. Independent and dependent variables are defined, characteristics of the population and sample are given, and methodology of data collection and analysis is reported.

Research Procedure

Since the purpose of this study was to determine whether student achievement in beginning college level electronics courses in which amateur radio activities were used as a motivational device was significantly different than student achievement in the same electronics course taught by conventional methods, a research design was chosen which utilized an experimental group exposed to amateur radio activities and a control group not exposed to amateur radio activities. The plan employed was the Nonequivalent Control Group Design described symbolically by Campbell and Stanley (1963, p. 47) as

$$\begin{array}{ccc} 0 & X & 0 \\ & & 0 \quad 0 \end{array}$$

"0" represent observations, and "X" identifies the treatment for the experimental class.

Student achievement was the dependent variable for the study, and achievement was defined and measured in terms of the point spread between an individual student's score on the pretest and his score earned on the posttest. The independent variable for the investigation

was the use made of amateur radio activities by the students and the instructor.

Development of the Measuring Instrument

A test instrument was developed for the purpose of measuring the achievement of the students. The test was composed of objective test items and conformed to the recommendations established by Michaels and Karnes (1950, p. 160) which were applicable to the multiple choice test items. The revised test was constructed so that its power exceeded the extent of subject matter the students were expected to learn during the entire period of instruction. Approximately seventy-five percent of the items were related to the subject matter of the beginning electronics course, and roughly twenty-five percent of the questions were germane to advanced material.

The instrument was presented to a six member jury of experts in the field of industrial education electronics for evaluation as to objectivity and validity of content. Members of the jury are listed in Appendix A. A copy of the instrument evaluation form may be found in Appendix B. The recommendations of the jury members served as the basis for the final revision of the test. A copy of the initial letter sent to each prospective juror can be found in Appendix C, and Appendices D and E include respectively the response card and cover letter included in the instrument mailing. A copy of the revised test instrument as administered to the groups is found in Appendix F.

Since the purpose of the instrument was to measure only achievement, the method chosen to determine test reliability was the Kuder-Richardson Formula (Ary, et al., 1972, p. 208) as follows:

$$R = \frac{K \overline{\sigma_x^2} - \bar{X} (K - \bar{X})}{\bar{X}^2 (K - 1)}$$

where

R = the reliability of the whole test

K = the number of items in the test

$\overline{\sigma_x^2}$ = the variance of the scores

$\bar{X}$ = the mean of the scores

Ary notes that the Kuder-Richardson method is appropriate to determine the reliability of a test designed to measure only one characteristic, for example, achievement, as the procedure emphasizes the equivalence of all test items (Ary, et al., 1972, p. 208). The test was found to have a reliability of .85.

Installation and Description of the Amateur Radio Station

Once the test instrument was completed, attention was given to the purchase and installation of the equipment necessary to establish an amateur radio station in the electronics laboratory used for the beginning electronics course. This equipment consisted of a transceiver, microphone, speaker, five antennas, a standing-wave ratio (SWR) and power output meter which was used mainly for tuning the antennas during installation, and a dummy antenna used for tuning the

transmitter. The transceiver was capable of transmitting and receiving Morse Code (CW) and speech; the single-side-band (SSB) communications technique was used for all voice conversations. Approximately 200 watts of power from the transceiver were switched to one of four dipole antennas for operation on either the eighty or forty meter amateur frequency bands or to a six element beam antenna when using frequencies in the ten, fifteen, or twenty meter bands. An antenna rotor allowed the beam to be used for any geographical direction, and the dipole antennas were installed to allow north to south or east to west communications. A world map showing radio districts and call letters was also a part of the station which was located in one corner of the electronics laboratory. All installation was performed prior to the beginning of the spring term; therefore, no last minute adjustments were necessary when students arrived at the beginning of the course.

Description of the Sample

The sample was drawn from a population comprised of all students who took the basic electronics course in the Department of Industrial and Technical Education at East Carolina University from September, 1971, through August, 1977. All classifications of students are included in the population which numbers approximately one hundred students per year. The investigation was performed during the spring term, 1976, and two sections of a beginning electronics course were scheduled. The sample for the

research consisted of those students who enrolled for the course. Assignment of experimental and control groups was randomly carried out by flipping a coin. Sixteen students were enrolled in the experimental and control groups initially, but one student in the control group dropped the course during the second week of classes, leaving a total sample of thirty-one students.

Several student characteristics were considered and analyzed in an effort to exhibit the extent of homogeneity between the experimental and control groups. Such characteristics included the student's classification, age, grade point average, area of concentration, previous electricity/electronics related experiences, course load, and general background information. Information regarding these characteristics was obtained through the use of a questionnaire given to the students on the first day of class. The questionnaire is recorded in Appendix G.

The sample consisted of a total of twelve seniors, fourteen juniors, and five sophomores. The students had an average age of twenty-two years, and thirteen percent were married. With the exception of three Virginians, all students were North Carolinians. Twenty-nine students were industrial education majors--ten majoring in industrial arts education and nineteen majoring in industrial technology. One student was a drama major, and one was majoring in music. Of those students majoring in industrial education, seven were undecided in their choice of a concentration area, and ten students were not concentrating in any one area. Of the twelve students

declaring areas of concentration, there were four students in each of the following subject areas: electronics, wood, and drafting. The overall grade point average of all students was 2.5 on a 4.0 scale. Approximately sixteen quarter hours (15.8 exactly) was the mean class load with sixty-one percent of the students working an average of ten hours per week in a part-time job.

Five students had served in the armed forces, and although most of the students had previous work experiences, only seven had work experiences related to the field of electricity and electronics. Twenty-four students had each completed an average of six hours in physics with a mean grade of 1.4 points on a 4.0 scale. An average of ten quarter hours of mathematics had been previously completed by each of the thirty-one students with a mean grade of approximately 2.0 points on a 4.0 scale. Only three students had received prior courses in electricity or electronics--two in the experimental class and one in the control class. Seventy-one percent of the students expressed interest in stereo music systems as an existing hobby, twenty-six percent included citizens band radio as a hobby, and three percent listed hobbies of amateur radio and radio controlled aircraft. No other electrical or electronic related hobbies were listed by the students.

An effort was made to ascertain the extent of homogeneity between the experimental and control groups in relation to the previously mentioned characteristics of the overall sample. Table 2 on the next page shows a comparison for the experimental and

TABLE 2
CHARACTERISTICS OF SAMPLE

Characteristic	Class	
	Experimental	Control
Student Classification		
Freshmen	0	0
Sophomores	1	4
Juniors	7	7
Seniors	8	4
Age		
Average	22.7	21.1
Major		
Industrial Arts	4	6
Industrial Technology	11	8
Other	1 (Drama)	1 (Music)
Overall Grade Point Average (on a 0.0 - 4.0 scale)		
	2.57	2.52
Course Load (in quarter hours)		
	15.6	16.0
Part-time Job		
Number of Students Working	10	9
Average Hours Worked Weekly	11	9.07
Previous Physics Courses		
Average Hours Completed	5	6.9
Average Grade Earned	1.23	1.58
Previous Mathematics Courses		
Average Hours Completed	10.3	9.67
Average Grade Earned	1.97	2.07
Previous Electronics Courses		
Number of Students	2	1
Hobbies		
Amateur Radio	1	0
Citizen's Band Radio	4	4
Stereo	10	12
Other (related)	1	0
Other (not related)	5	1

control groups for certain sample characteristics. This table (p. 47) indicates that the means of the experimental and control groups were close to each other in relation to overall grade point average, course load, the number of students holding part-time jobs and the number of hours worked per week, grades earned in previously taken physics and mathematics courses, and the number of students having electronics related hobbies. The larger number of seniors in the experimental group than in the control group and the higher average age of the students in the experimental group could suggest that the experimental group was more mature than the control group.

Data of the student characteristics were analyzed using analysis of variance. Except for marital status, no significant differences in characteristics between the experimental and control classes were observed at the .05 level of confidence. Analysis of variance tables for student characteristics are given in Appendix H.

Description of the Experimental Group Treatment

Amateur radio was introduced to the students by means of a movie, class discussions, demonstration of the "ham" station, and a guest speaker. Introduction was begun on the first class day with a presentation of "Ham's Wide World," a film produced for television by the American Radio Relay League for purposes of informing the layman of the services and benefits of "ham" radio and the advantages of amateur radio as a hobby. The thirty minute movie narrated by amateur radio operators Arthur Godfrey and Senator Barry

Goldwater was appropriate as an initial device to familiarize the students with amateur radio as it related the history, international breadth, activities, equipment needed, and necessary licenses of the hobby. Following the movie, a brief question and answer period was held.

During the second class meeting, the amateur radio station WB4EJQ was demonstrated to the students. Operation of the transceiver was illustrated, and student operating privileges and limitations were emphasized as students were non-licensed but could engage in transmitted conversations under the supervision of the licensed class instructor. In order to insure a contact during the demonstration and to conserve time, the instructor had previously made contact with another radio amateur and asked him to listen at the time of demonstration for a call from the group. The twenty minute demonstration generated a great deal of excitement as several students who were in Greenville, North Carolina, held brief conversations via radio with a "ham" in Florida.

Question and answer periods of approximately ten minutes duration were held in many of the class meetings which followed the demonstration. These discussions usually occurred at the beginning of the class period and were about topics related to various aspects of amateur radio. Modes of operation were considered, with keen student interest in the more exotic types of amateur radio communications--slow scan television, teletype, and communications via satellites. Equipment types, cost, and availability were discussed, and attention

was given to operating regulations and licensing procedures. Students were also interested in operating contests and awards.

In order for the students to learn about amateur radio from a viewpoint other than that of the instructor, a local "ham" operator, Charley Wells, K4SKI, was invited to the class meeting to discuss amateur radio from a personal standpoint and answer related questions. Mr. Wells' discussion was beneficial in relating to the students the public service and emergency communications aspects of amateur radio through the recounting of some of his own experiences. Mr. Wells was eminently qualified for this task as he has appeared on the television program, "To Tell the Truth," and has been the guest of presidents, kings, and ambassadors in many foreign countries in recognition of his life saving efforts with his hobby of amateur radio.

Students were given access to the station thirty minutes prior to class time, from 7:30 A.M. to 8:00 A.M., and during the daily class break, from approximately 8:50 A.M. to 9:05 A.M. Students could also use the station at selected times in the afternoon, but no specific afternoon schedule was developed. In order to allow all sixteen students equal class time with the station, students were divided into four groups with four students per group. The availability of the station during class hours was rotated among the groups in such a manner that allowed a given group access to the station during the class break every fourth day of class. No rotational scheme was employed for use of the amateur radio facilities for times other than actual class hours.

Once the groupings of students were made, students decided to compete among groups in such contests as working all states (WAS), working all continents (WAC), working the largest number of states and foreign countries, and the longest distance. The students would decide which frequency bands they wished to use, and the instructor would tune the transceiver for the desired frequency and switch in the proper antenna. Students could adjust only the fine tuning control for receiving and the volume control on the transceiver and the push-to-talk switch on the microphone. Under the instructor's supervision, the students were allowed to call other stations, make radio contact, and sign-off with that station when the conversation was ended. Contacts were made with radio amateurs in many parts of the world, and students talked with "hams" as close as five miles away and as far away as the Indian Ocean and the USSR. A log of the communications made is found in Appendix I.

Some additional exposure to the subject matter was received by the students through the contacts they made. Many radio amateurs with whom the students talked would ask about the students' studies, career plans, etc., and on many occasions the conversations would lead to a discussion of some technical topic which the students were studying in the electronics course. As many radio amateurs are

well versed in the field of electricity and electronics, they proved to be effective instructors in some cases.

In addition to any impromptu instructional advantage which use of the amateur radio station provided students through conversations with other "hams," the facility was also employed as a scheduled instructional aid to help clarify principles and demonstrate applications of certain electrical and electronic components and circuits.

The beginning electronics course for both the experimental and control groups was started with a general introduction to the field of electronics with emphasis being given to broad applications of electronic systems in modern society. The dependence upon electronics was discussed as it appears in the areas of mass communications, manufacturing techniques, climate control inside buildings, related hobbies, and so forth. Some of these electronic systems were considered in terms of their basic elements such as power supplies, oscillators, and amplifiers. These elements were defined regarding their function, and then presented as a collection of circuits and components. Thus, the subject matter of the course was from general systems to specific circuits and components such as series and parallel circuits, and resistors, capacitors, transformers, et cetera.

The amateur radio station proved especially useful in illustrating many of the above topics for the experimental class. In order to listen to another "ham" station or to transmit a signal, a particular frequency had to be selected and produced. It was noted that such frequencies were produced by an oscillator contained

in the transceiver, and that selection of a given frequency was made by tuning the oscillator to produce that frequency. Through the use of the transceiver, students were able to understand that an oscillator circuit may produce only one fixed frequency or be tuned to create one of a range of frequencies and that different oscillators are used for diverse frequency bands.

Understanding the purposes of an amplifier circuit was made easier through the use of the "ham" station. It became clear to the students that sufficient power for transmission was not available from the oscillator alone, and that once the oscillator had produced the desired frequency, that oscillator signal was of little value until the amplifiers were switched on and tuned to that particular frequency. It was only then that transmission was possible. Of course, neither the oscillator nor amplifiers could operate without the proper power, and three power supplies were contained in the transceiver, a low voltage supply, a high voltage supply, and a heater power supply for the tube filaments in the final amplifier. Each of these power supplies produced a different voltage value from that of the 117 volt wall receptacle into which the transceiver was plugged. Two of the power supplies changed the type of voltage from alternating current to direct current (AC to DC). These three power supplies were individually switched on and off from the front panel of the transceiver, so demonstration of the effect each power supply had on transceiver operation was easily accomplished.

Therefore, the function of a power supply circuit was demonstrated to the students.

Utilization of the amateur radio station was also made in the instruction of basic electrical principles. The antenna system was beneficial in relating some characteristics of series and parallel circuits, as the power meter was connected in series with the antennas and some of the dipole antennas were joined in a parallel arrangement. Applications of components were easily shown via the entire station. The concepts of resistance to current flow and the use of resistors in circuits were demonstrated using a device called a dummy antenna. The only electrical component in the dummy antenna was a resistor. This device was used as a replacement for an actual antenna during tuning of the transmitter. The resistor of the dummy antenna provided a proper load for the transmitter, yet prevented emission of radio waves into the atmosphere. Other components studied in the beginning electronics course were capacitors, inductors, transformers, and introductory material relative to vacuum tubes and transistors. Circuits of the amateur radio station were used as examples of practical applications of each of these components.

Perhaps the greatest instructional benefit of the amateur radio activities was manifested in the last unit of instruction in the course--introduction to electronic communications. A very broad preliminary treatment of mass communications and the dependence of its existence upon the field of electronics was made at the

beginning of the course as lead-in material to a study of basic electrical and electronic principles. The purpose of the electronic communications unit near the conclusion of the course was to provide the students with a general understanding of the operation of radio and television systems. Students learned how the electromagnetic frequency spectrum was divided and frequencies allotted to various radio services such as AM radio, television, and amateur radio, how a transmitter develops a broadcast signal and transmits it through the atmosphere, and how radio and television receivers convert the radio waves into sound and pictures.

Use of the amateur radio station as an instructional aid was especially appropriate for the unit on radio communications. When the topic of allocation of frequencies within the radio spectrum was studied, students could immediately relate to it because of their involvement in amateur radio activities. This student reaction to the subject matter was also present in other topics of the unit. Some topics were easily demonstrated to the students through utilization of the amateur radio facilities. Two such subjects were radio wave propagation and the effect the atmosphere has on various radio frequencies. Different amateur radio frequency bands were used to show that certain frequencies can be used only for relatively short distances (one hundred miles or less) while other frequencies could be employed for world wide communications. Therefore, in addition to being an enjoyable experience for the students, class involvement in amateur radio activities was helpful as an instructional

device to demonstrate many of the topics studied in the beginning electronics course.

Efforts were made to minimize the effects of extraneous variables on the outcome of the investigation by treating the two groups as similarly as possible except for the experimental treatment. Both groups met in the morning, the experimental group from 8:00 A.M. to 9:50 A.M. and the control group from 10:00 A.M. to 11:50 A.M. The groups had the same course content and identical class and laboratory assignments. They were of essentially the same size: the experimental group had sixteen students and the control group fifteen. Except for the employment of amateur radio activities as a motivational device and an instructional aid for the experimental group, the methods of instruction used for both experimental and control groups were the same. Lectures, demonstrations, laboratory exercises, and audio-visual presentations were made to be as identical as possible for the two groups.

Field trips were made to local television and radio stations and were taken by the two groups collectively. Subject matter material, assignments, and tests were the same in terms of content and time duration for both groups. In an effort to control for the Hawthorne effect (Ary, et al., 1972), neither group nor individual students were told that they were participating in an educational experiment.

Data Collection and Analysis

A pretest was administered to both the experimental and control groups for purposes of ascertaining the students' prior understanding of the subject matter and the extent of homogeneity between the groups relative to subject matter. The same test instrument was used for both the experimental and control groups, and both groups were tested simultaneously under identical testing conditions.

Both groups were given a posttest to determine the students' knowledge and understanding at the end of the course. The experimental and control groups were again combined, as in the pretest procedure, for the simultaneous administration of the posttest to both groups. The test instrument used for the pretest was also used for the posttest. No attempt was made to separate students in the experimental group from those in the control group in terms of seating arrangement for either the pretest or posttest. Students were allowed to select their own seats; thus, there was a merging of the two groups with students representing each group in all areas of the classroom. The gain scores (difference between pretest and posttest) between the control and experimental groups was the data analyzed for testing of the hypothesis.

Because of its precision and sensitivity, the analysis of covariance was used to analyze the data statistically. A test for regression coefficients was performed to determine if there did or did not exist a significant difference between the two groups

relative to prior knowledge of the subject matter. A within group correlation was used to indicate the extent of similarity between the two groups. A "t" test was utilized to test for significant achievement within each group. A test for adjusted means was employed as the statistical tool for examination of the data regarding student achievement between groups and for testing the null hypothesis. Pretest and posttest scores were used in the data analysis to test the hypothesis with the pretest scores being treated as the covariate.

Summary

The Nonequivalent Control Group Design (Campbell and Stanley, 1963, p. 47) was chosen as the plan for the study. A control group was taught the subject matter by means of conventional methods (i.e., lecture, demonstration, audio-visuals, field trip, and laboratory experiences) without the students being exposed to amateur radio activities. An experimental group was taught the subject matter utilizing amateur radio activities in addition to conventional methods of instruction. Efforts were made to exhibit the extent of homogeneity between the experimental and control groups and to control confounding variables which might influence the results of the investigation.

A test instrument was developed for the purpose of measuring the achievement of the students. Student achievement was the dependent variable for the study, and achievement was defined and measured in terms of the point spread between an individual student's score on

the pretest and his score on the posttest. The independent variable for the investigation was the uses made of amateur radio activities by the students and the instructor. These activities included a movie, class discussions, demonstrations of the "ham" station, and a guest speaker. Students had access to the "ham" station at specified periods throughout the day. The station was also used regularly throughout the course to illustrate various electronics principles being studied in the course.

The sample consisted of students enrolled in the beginning electronics course majoring in the Department of Industrial and Technical Education at East Carolina University in Greenville, North Carolina during the spring term, 1976. A total of thirty-one students were used--sixteen in the experimental group and fifteen in the control group.

Analysis of covariance was employed to analyze the data statistically. Tests were performed both for regression coefficients and for adjusted means.

CHAPTER IV

RESULTS

Scores made on the pretest and posttest and the differences between these scores were analyzed for each individual. Data obtained from the control and experimental groups will be presented in terms of overall means of each group and with reference to quartiles of each group. A discussion of the analysis of data between the two groups overall will be made, and the null hypothesis tested.

Data Analysis Techniques

Analysis of covariance was employed as the statistical technique to analyze the data between the experimental and control groups. A test for regression coefficients was performed to determine if a significant difference existed between the experimental and control groups with regard to prior knowledge of the subject matter.

Achievement was defined as the difference between an individual student's pretest score and posttest score. A correlated "t" test was utilized to test for significant achievement within each group. The analysis of covariance test for adjusted means was used for examination of the data relative to student achievement between groups and for testing the null hypothesis. Pretest and posttest scores were used in the data analysis to test the hypothesis with the pretest scores treated as the covariate.

Description and Interpretation of Findings

Pretest scores revealed that most students in the sample had little prior knowledge of the subject matter presented in the basic electronics course. With a possible perfect score of 100 points, the average grade achieved by the entire sample was 14.89 points, and the range of scores for the total sample was from 1.00 points to 49.55 points. Pretest scores ranged from 4.90 points to 28.45 points in the experimental group and from 1.00 hundredths points to 49.55 points in the control group. Figure 2 shows the mean pretest scores for the experimental and control groups.

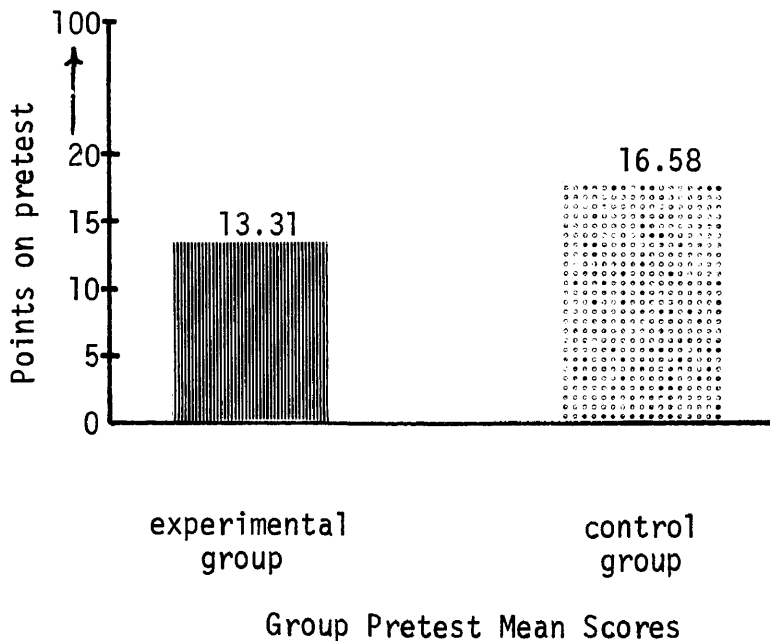
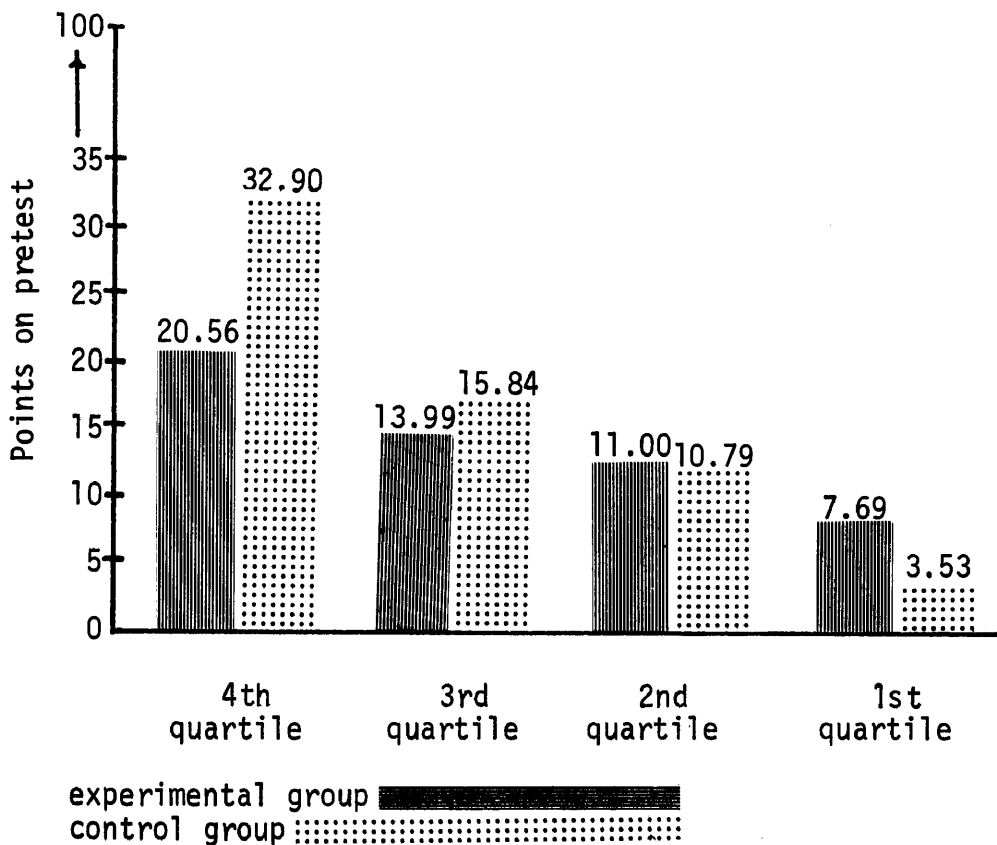


Figure 2

An examination of Figure 2 indicates that the experimental group had slightly less prior knowledge of electronic subject matter than the

control group. This is illustrated by the fact that the mean pretest score for the experimental group was 3.27 points less than the score achieved by the control group. Thus, if any initial advantage was possessed by either group, the control group was in the most advantageous position. However, the statistics do not support this position.

Using the pretest scores as the criterion, students were ranked into quarters for the experimental and control groups. A presentation of pretest mean scores by quarters for each group is presented in Figure 3.



Quartile Pretest Mean Scores

Figure 3

Students who ranked in the upper two quarters of the experimental group earned lower scores on the pretest than those students of the same quartile ranks of the control group. Thus, of those students having the greatest prior knowledge of the material studied in the beginning electronics course as indicated by their being ranked above the second quartile, those in the control group apparently were better informed than those of the experimental group. This relationship of the two classes is reversed in the lower two quartiles. Although students who ranked between the first and second quartiles of the control group earned slightly lower scores on the pretest than did comparably ranked students of the experimental group, the closeness of the scores would indicate that students between the first and second quartiles of the experimental group had approximately the same amount of knowledge of the subject matter as their counterparts in the control group. Scores also indicate that students in the control group who ranked below the first quartile knew less about the subject of electronics than did their counterparts in the experimental group.

A statistical comparison of the pretest scores made by the two groups was performed in order to determine if significant differences existed between the experimental and control groups in terms of the amount of prior knowledge of the subject matter. The analysis of covariance technique of regression coefficients was employed for this determination, and no significant differences

between the groups were found at the .05 level of confidence. Since the F statistic was insufficient to indicate a significant difference, the conclusion was drawn that even though slight differences existed in the degree of knowledge obtained concerning the subject matter between the experimental and control groups as indicated by pretest scores, those differences were insignificant; and for the purposes of this research project, the two groups were considered homogeneous in regard to prior knowledge of the subject matter covered in the electronics course. The table for regression coefficients is presented in Table 3.

TABLE 3
SUMMARY OF REGRESSION COEFFICIENTS FOR PRETEST

Source	Degrees of Freedom	Sum of Squares	Mean Square	F*
Total	28	2475.32	----	0.20
Treatment	1	18.59	18.59	
Error	27	2456.73	90.99	

*F needed for significance at the .05 level of confidence is 4.21.

Performance on the posttest by the experimental group was almost identical to that of the control group; only a 0.22 point difference existed between the two groups in posttest mean values. The mean score of the overall sample on the posttest was 56.57 points with a possible perfect score of 100 points, and the adjusted mean for the experimental group was 56.95 points and 56.15 points for the control

group. The actual mean posttest scores for the two groups are graphically indicated by Figure 4.

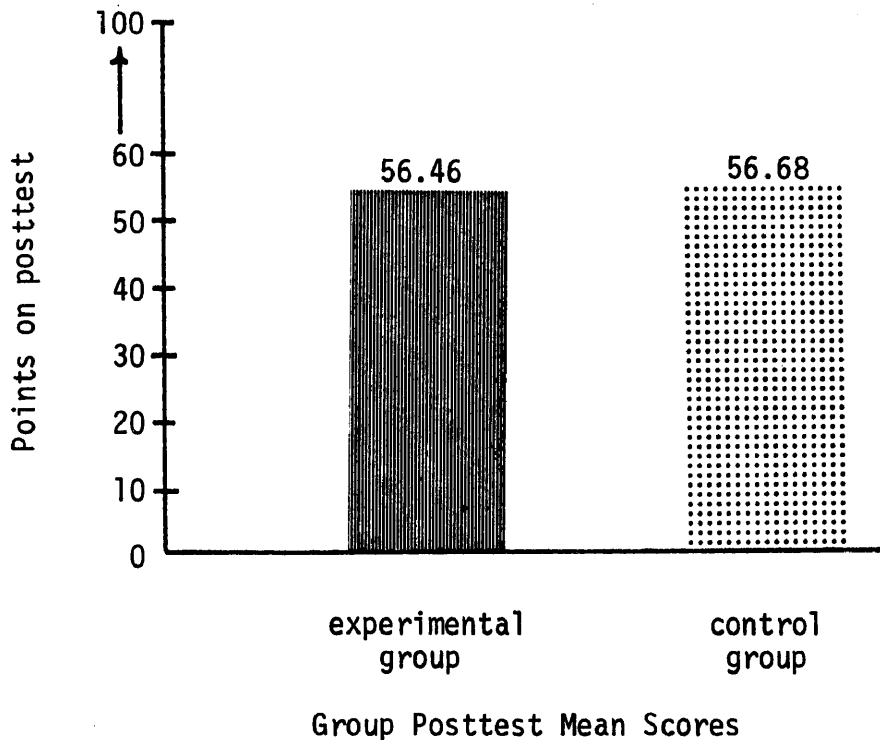
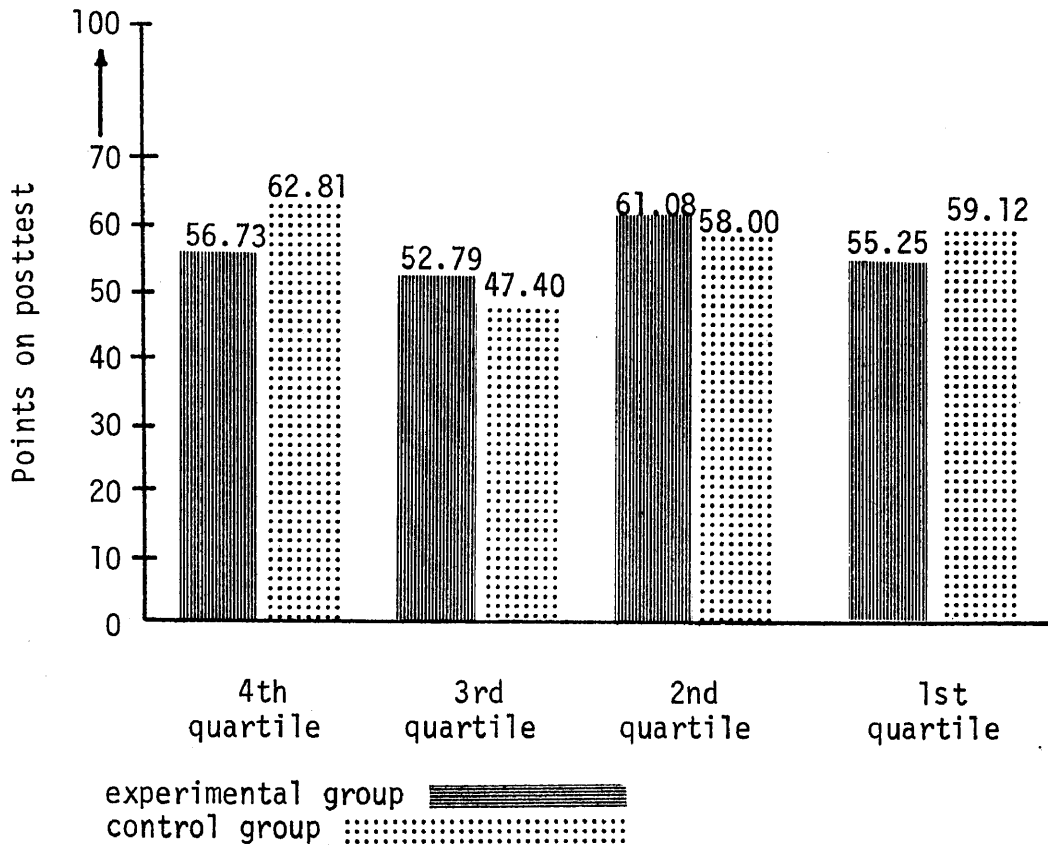


Figure 4

The fact that the two groups performed almost equally well on the posttest indicates that, at the end of the course, the experimental and control groups had approximately the same understanding of the material studied in the beginning electronics course.

The relationship of quartile ranks to posttest scores is shown in Figure 5 (p. 66). Pretest scores were used as the basis for ranking students in regard to quartiles. Accomplishment on the posttest by those students above the third and below the first quartiles of the control group exceeded that of similarly ranked students



Quartile Posttest Mean Scores

Figure 5

in the experimental group. However, the situation was reversed in the two center quartile ranks with students in the experimental group achieving higher scores than their counterparts in the control group.

An inference can be made from Figure 5 that the degree of understanding of the subject matter does not vary widely between the experimental and control groups or among the quartile ranks within each group. It appears that the greatest knowledge of the entire sample is held by students ranking above the third quartile of the control group,

and the least among those students ranking between the second and third quartiles of the control group. The range of mean posttest scores for the quartiles in the control group was from 26.35 points to 75.60 points, and the range of scores for the experimental group was from 48.60 points to 69.90 points. Thus, greater differences in extent of knowledge of subject matter existed in the control group than in the experimental group as indicated by posttest scores.

A comparison of student achievement between the experimental and control groups reveals the experimental group had slightly greater achievement than did the control group. Achievement was measured in terms of the point spread between an individual student's pretest score and his posttest score, and the mean achievement values for the experimental and control groups are shown in Figure 6.

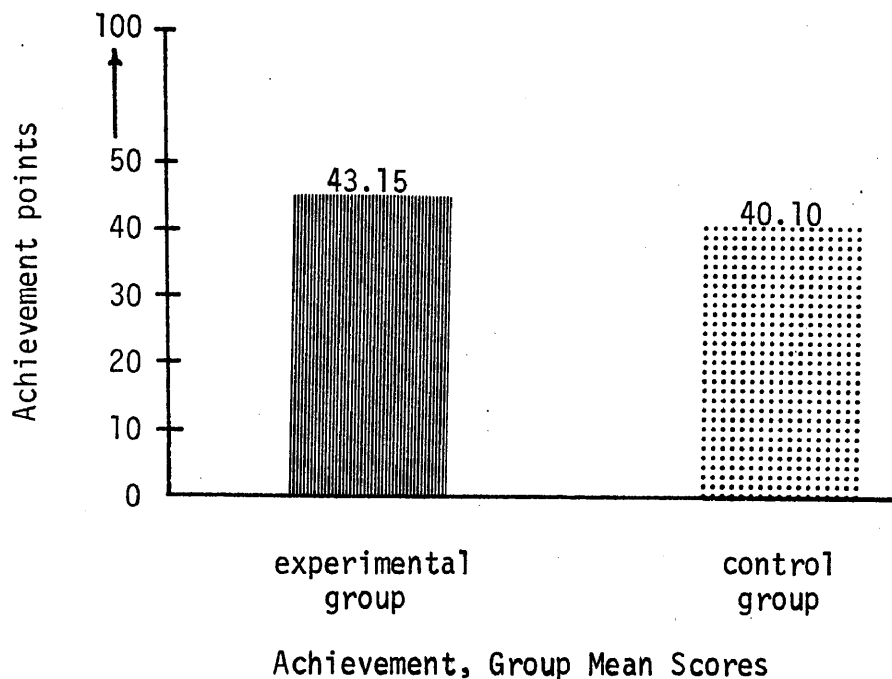


Figure 6

Based upon Figure 6 (p. 67), a judgment could be made that students in the experimental group learned more than the students of the control group. Since the mean pretest score of the control group exceeded that of the experimental group by 3.27 points and the mean posttest scores of the two groups differed only by 0.22 points, the conclusion could be drawn that any additional achievement by the experimental group, as indicated by test scores, was possibly due to a positive effect of the experimental treatment.

Achievement gain scores indicate that students in both groups acquired a significantly greater understanding of the subject matter during the beginning electronics course than they had prior to taking the course. To determine to some degree the extent of learning of students in each class, achievement within groups was analyzed through the use of a statistical correlated "t" test; and the data is presented in Table 4.

TABLE 4

SUMMARY OF "t" TEST FOR ACHIEVEMENT WITHIN GROUPS

Group	Pretest Mean	Posttest Mean	Mean Difference	t
Experimental	13.31	56.46	+43.15	9.06*
Control	16.58	56.68	+40.10	4.65**

* "t" needed for .01 level of confidence is 2.95.

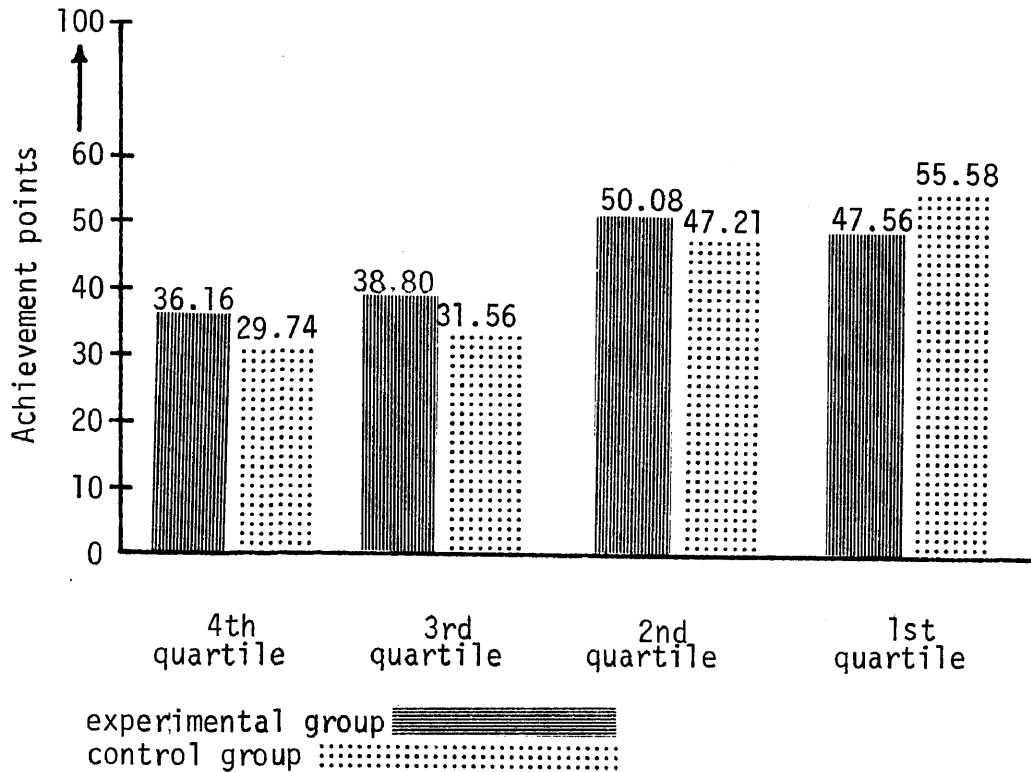
** "t" needed for .01 level of confidence is 2.98.

The "t" test analysis revealed that students in both the experimental and control classes made significant gains in knowledge as

indicated by test scores. Thus, it appears that both the experimental and control methods are effective teaching procedures in terms of both the groups as a whole and in regard to the relative effectiveness each procedure had on students ranked in the various quartiles.

Of those students in the control group, there was an inverse relationship between achievement and the student's quartile rank--the ranks being determined by the pretest scores. Those students above the third quartile had the smallest amount of achievement, and those below the first quartile the greatest. This inverse relationship of rank and accomplishment was not totally true for students in the experimental group, but very nearly so. The only difference in the rank-achievement relationship of the experimental group from that of the control group was that those students ranking between the first and second quartiles of the experimental group enjoyed slightly higher achievement levels than those ranking below the first quartile. The mean achievement scores by quarters of the two groups are illustrated in Figure 7 (p. 70). Both the experimental and control teaching methods were least effective with those students possessing the greatest prior knowledge of the subject matter and most effective with those students who, at the start of the course, had less understanding of the subjects studied in the beginning electronics course.

Other information indicated by Figure 7 (p. 70) is that students in the experimental group who ranked in the top seventy-five percent accomplished slightly greater achievement scores than those students of the same quartile ranks in the control group. However, students ranking below the first quartile of the experimental group earned



Achievement, Quartile Mean Scores

Figure 7

lower achievement scores than those of the control group. The within groups correlation of pretest to posttest scores was 0.33.

Results of Hypothesis Testing

In order to examine objectively the extent of achievement of students in the experimental group relative to that of students in the control group, the following null hypothesis was tested: There is no significant difference in achievement between students enrolled in a beginning electronics course in which amateur radio activities are used as an instructional aid and students who take the same

course without amateur radio activities. The analysis of covariance test for adjusted means was selected as the statistical tool for examination of the data to test the hypothesis. This statistical technique was employed because of its sensitivity. Pretest scores were used as the covariate, and the posttest scores were considered the variable. The difference between the pretest and posttest reflected student achievement. The raw data analyzed for testing the hypothesis are contained in Appendix J for the experimental group and Appendix K for the control group. The analysis of the scores is presented in Table 5.

TABLE 5
SUMMARY OF ANALYSIS OF COVARIANCE FOR ACHIEVEMENT

Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	29	2480.05	-----	0.05*
Treatment	1	4.85	4.85	
Error	28	2475.2	88.40	

*F needed for significance at the .05 level of confidence is 4.20.

An insufficient value of the F statistic was obtained to indicate a significant difference in achievement between the experimental and control groups; therefore, the null hypothesis could not be rejected. The data gave no indication that those students who were taught using methods which included amateur radio activities made significantly higher achievement scores than did those students taught by methods devoid of amateur radio activities. Furthermore,

the data would not support the inference that those students exposed to amateur radio activities as part of the instructional program acquired any lesser degree of achievement scores than those students in the control group. The conclusion could be drawn that the two methods of instruction were perhaps equally effective toward motivating students in the beginning electronics course in obtaining academic performance.

Summary

The results of the pretest given to all students in the sample at the start of the course revealed that most students had little or no prior knowledge of the subject matter germane to the beginning electronics course. An examination of the pretest scores showed a slightly greater degree of familiarity with the subject matter among those students in the control group. A statistical comparison of the pretest scores earned by the two groups was made using the analysis of covariance regression coefficient technique. No significant differences were found, so the two groups were considered to be approximately equal in their prior knowledge of the subjects studied in the course.

The fact that both groups achieved almost equal performance on the posttest indicated the same degree of understanding of the subject matter between the experimental and control groups. The differences in pretest and posttest scores were used to relate achievement. In both groups, achievement was greatest among those students

whose pretest scores were below the second quartile, and students having the greatest prior knowledge of the subject acquired the least achievement. This relationship of achievement to quartiles indicated that both the experimental and control methods had approximately the same effect on students relative to their positions between quartiles. Although the experimental group as a whole had slightly greater achievement scores than did the control group, both groups showed significant achievement.

An examination of achievement scores by the use of analysis of covariance revealed that no significantly greater achievement values were obtained by the experimental group than by the control group; therefore, the null hypothesis was not rejected. It was then concluded that even though the experimental group did no better regarding achievement than did the control group, neither did they do any worse. Thus, the two methods appear to be equally effective in promoting student achievement in the beginning electronics course.

CHAPTER V

SUMMARY AND CONCLUSIONS

The problem, purpose, and hypothesis of the investigation are restated in this chapter, and summarizations of the rationale, procedures, and findings are presented. Conclusions and recommendations based on the information gathered in the study are made.

Summary of Rationale

In their desire for developing a more beneficial and enjoyable learning environment than presently existed, many educators have employed numerous techniques and devices designed to kindle increased student motivation for learning. Support was found for the benefits of student participation in the learning process through such means as projects or games. Amateur radio was employed by several authors as a motivational device, and its use incorporated many of the factors of motivation which had been discussed. The only known research project dealing with amateur radio recommended its use as a means of nurturing and encouraging interest in technical subjects.

Since amateur radio activities were beginning to be found in increasing numbers in schools across the United States, educators must have found them beneficial in the learning process.

All devices employed in schools for the purpose of motivating students toward increased learning should be tested as to their effectiveness and information be obtained which would allow educators the opportunity for comparison of methods. Data, similar to that existing on several other motivational devices, were needed to determine the effectiveness of amateur radio activities on student motivation.

Statement of the Problem

In view of the apparent popularity of the use of amateur radio activities as motivational techniques among some educators, there was a need to investigate the relationship of amateur radio activities to student achievement. The problem of determining what benefits, if any, amateur radio activities might have on student achievement needed resolving. Such an inquiry was appropriate as, unlike the motivational techniques of individualized instruction, role playing, and others, literature was not available which was addressed to the effect amateur radio activities have on student achievement. Much time, effort, and money may be spent toward the establishment of an amateur radio station in an industrial education electronics laboratory; thus, it would be advantageous for educators to know of any benefits relative to student achievement which amateur radio activities might provide, prior to the expenditure of their resources.

Purpose of the Study

The purpose of this study was to determine whether student achievement in beginning college level electronics courses in which amateur radio activities were used as a motivational device was significantly different from student achievement in the same electronics course taught by conventional methods.

Null Hypothesis

Differences in overall achievement between students in the experimental class and control class were determined by testing the following null hypothesis: There is no significant difference in achievement between students enrolled in a beginning electronics course in which amateur radio activities are used as an instructional aid and students who take the same course without amateur radio activities.

Summary of Procedure

The basic plan used for the investigation was the Nonequivalent Control Group Design (Campbell and Stanley, 1963, p. 47) and described symbolically as follows:

O X O

O O

"O" represents observations, and "X" represents the treatment for the experimental class.

Two sections of a beginning electronics class were scheduled. One section was chosen at random to be the experimental group, and the other was designated as the control group. The control group was taught the subject matter by means of conventional methods (i.e., lecture, demonstration, audio-visuals, field trip, and laboratory experiences) without students being exposed to amateur radio activities for instruction. An experimental group was taught the subject matter utilizing amateur radio activities in addition to conventional methods of instruction. The dependent variable was student achievement, and the independent variable was the uses made of amateur radio activities by the students and the instructor. Student achievement was measured in terms of the point spread between the pretest and posttest scores.

A test instrument was developed for the purpose of measuring the achievement of the students. The test was composed of objective test items and was constructed so its power exceeded the extent of subject matter the students were expected to learn during the entire period of instruction. A jury of experts evaluated the test for objectivity and validity of content. The test was found to have a reliability of .85.

In order to minimize the effects of extraneous variables on the outcome of the investigation, the two groups were conducted as similarly as possible except for the experimental treatment. Both groups met in the morning, were of essentially the same size, had the same course content, and identical class and laboratory assignments.

The sample was drawn from a population comprised of all students who take the basic electronics course in the Department of Industrial Education at East Carolina University. Those thirty-one students who enrolled for the course during the spring term, 1976, determined the actual sample for the study.

The majority of the students were juniors and seniors having an average age of twenty-two years. Approximately sixteen quarter hours was the mean course load, and sixty-one percent of the students worked an average of ten hours per week at a part-time job. Most of the sample had completed previous physics and math courses, not served in the armed forces, and had previous work experiences which did not relate to electronics. All but two students were industrial education majors.

The amateur radio station consisted mainly of a transceiver, microphone, speaker, and an antenna system which allowed for transmitting to and receiving from all geographical directions on any one of several amateur frequency bands. A world map showing countries and the radio districts within them was part of the station which was located in one rear corner of the electronics laboratory.

Amateur radio was introduced to the students via the movie, "Ham's Wide World," class discussions, and demonstrations of the station. Modes of operation were discussed, such as Morse Code (cw), voice using amplitude modulation (AM), frequency modulation (FM), and single-side-band (SSB), slow scan television, television, teletype, and communication via satellites. Other topics included

equipment, regulations, and licensing procedures, with special emphasis given to student operating privileges allowed under the supervision of the licensed class instructor. A guest speaker discussed with the students amateur radio topics based upon his own involvement with the hobby.

The "ham" station was available to the students prior to each class period, during the class break, and in the afternoons. Students were divided into four teams of four students per team, and each team rotated in its use of the station during the class breaks. A sense of competition developed among the teams regarding the quantity and distance of contacts made.

Instructional use of the station was made in relation to several concepts studied in the course. The equipment represented examples of practical applications of many components and circuits studied, thereby perhaps providing some relevance to an otherwise abstract topic. Operating on the various amateur bands was useful in learning some concepts of alternating current, frequency, power, and theory relating to receivers, transmitters, antennas, and other communication systems.

Gathering of data was accomplished through the use of an achievement test used for both a pretest and a posttest. A pretest was administered simultaneously to the experimental and control groups. A posttest was given to determine the students' knowledge and understanding at the end of the course. The differential of pretest and posttest scores was the data analyzed for testing the hypothesis.

Information concerning sample characteristics was obtained via a student questionnaire.

The statistical technique of analysis of covariance regression coefficients was utilized for examination of pretest scores of the sample to detect the possible presence of significant differences between the control and experimental groups regarding prior knowledge of the subject matter. A "t" test was employed to check for significant achievement within each group, and the analysis of covariance test for adjusted means was selected as the statistical technique for examination of student achievement between groups. The analysis of covariance technique was selected because of its high precision.

Summary of Findings and Conclusions

Numerical grades earned on the pretest indicated that most students had little or no knowledge of the subject matter studied in the basic electronics course. Further analysis of the scores revealed that students in the control group were slightly more informed regarding the subject material than those enrolled in the experimental group, but an analysis of covariance statistical comparison of the two groups showed no significant difference between them in terms of previously obtained knowledge of electricity and electronics. Thus, the slight difference in knowledge indicated by the pretest scores between the two groups was considered insignificant, and the groups were treated as being essentially equal in this regard.

The two groups achieved practically identical scores on the post-test which indicated that at the end of the course both groups had achieved approximately the same understanding of the subject material. Achievement was measured relative to the point spread between the pretest and posttest scores. Those students whose pretest scores were below the first quartile of each group obtained the highest achievement, and those whose scores were above the third quartile of each group acquired the least. Both the experimental and control groups exhibited approximately the same relationship of achievement to quartiles.

A statistical "t" test was utilized to test for significant achievement within the groups, and results showed that both the experimental and control groups obtained significant achievement. Although the experimental group had slightly greater achievement than did the control group, an examination of achievement scores with the analysis of covariance technique revealed the absence of any statistically significant difference between the experimental and control groups in regard to achievement. In view of these test results, the null hypothesis was not rejected.

The data indicated that even though the experimental group did not have significantly greater achievement than did the control group, those students exposed to amateur radio activities did no worse. Thus, the experimental and control methods appeared to be perhaps equally effective in promoting student achievement in the beginning electronics course.

Recommendations

Based upon the findings reported in the cited literature, amateur radio activities are recommended for education because they can be used as the following:

1. An instructional tool in certain technical subjects such as electronic communications.
2. An asset in developing desirable public relations.
3. A potential motivational device for some students.
4. A stimulus for career thinking among students.

Analysis of data from the present study indicates that use of amateur radio activities did not significantly stimulate increases in achievement in those students tested; however, because of the favorable influence such activities appeared to have on classroom atmosphere, as experienced by the instructor, it is thought that employment of amateur radio activities has potential value in education. Such values could be discovered through further research. The following are topics recommended for additional research:

1. The effect that use of amateur radio activities might have on student achievement in other electronics courses at the college level of instruction.
2. The effect that use of amateur radio activities might have on student achievement in high school, junior high, or elementary industrial education electronics or science programs.
3. The effect that use of amateur radio activities might have on the number of students who elect to take additional electronics courses.

4. Utilization of amateur radio activities in career education programs.
5. Resource research of amateur radio with emphasis on curriculum development for electronic programs.
6. Studies determining the long range effectiveness of the use of amateur radio activities.

Summary

This study was predicated on the belief that increasing student motivation would result in greater academic achievement on the part of the student. A review of the literature revealed many authors who supported this premise. The literature indicated that if the learning experiences were more enjoyable and relevant, the amount of learning would increase as a result of greater student interest. Several studies which investigated motivation, its effects on learning, and various motivational techniques were cited in this report. Some of the same factors which many of these studies labeled as advantageous in creating motivation by using other motivational techniques were contained in the projected use of amateur radio activities as a device to stimulate motivation. Some such characteristics of amateur radio activities were their ability to involve students on both an individual and a collective basis, provide relevance to certain subject matter (for example, basic electronics), arouse the interest of students, provide enjoyable experiences, provide for competition among students, and allow for

avocational interests. Thus amateur radio activities were possibly motivational devices.

Amateur radio activities were being employed by a growing number of educators as a motivational technique; however, since no research was found which addressed the effect amateur radio activities have on student achievement, the goal of this investigation was to discover such effect.

An amateur radio station was installed in the electronics laboratory at East Carolina University, and two beginning electronics classes were taught--one class using amateur radio activities as a motivational device, the other serving as a control group. A pretest and posttest were administered to each group, and achievement was compared between the groups. The data analysis showed no significant difference in the achievement between the experimental and control groups. Both groups made significant gains in understanding of the subject matter, with those students who were taught via amateur radio activities doing at least as well as those taught by the conventional method. Although the data did not provide any tangible advantage of amateur radio as reflected in measured achievement, amateur radio activities helped produce a relaxed classroom atmosphere and provided some fun for both the students and the instructor.

The addition of amateur radio activities into the instructional program for the field of electronics has potential value. Perhaps through additional research, such value can be identified and its effects examined.

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APPENDIX A

INSTRUMENT EVALUATION JURY

INSTRUMENT EVALUATION JURY

1. Mr. Fred Culpepper, Professor
Industrial Education Department
Old Dominion University
Norfolk, Virginia 23508
2. Mr. Walter Deal, Assistant Professor
Industrial Education Department
Old Dominion University
Norfolk, Virginia 23508
3. Dr. William Dugger, Chairman
Industrial Arts Department
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061
4. Mr. Chris L. Flester, Instructor
Industrial Arts Department
Appalachian State University
Boone, North Carolina 28607
5. Dr. Isaac Hampton, Professor
Department of Industrial Education
Sam Houston State University
Huntsville, Texas 77340
6. Dr. Talmadge Young, Chairman
Industrial Arts Department
North Carolina State University
Raleigh, North Carolina 27607

APPENDIX B

INSTRUMENT EVALUATION

INSTRUMENT EVALUATION

The purpose of the test instrument is to measure student achievement in a college level beginning electricity/electronics course. It is assumed that no student will make a perfect score on the test as 75% of the items are on beginning level subject matter and 25% are concerned with advanced material.

Please evaluate the enclosed test instrument by answering the following questions and commenting as to reasons for any "no" responses.

1. In terms of content and form, is the test in concordance with the purpose as stated above?

yes _____

no _____

Comment:

2. Does the test adequately sample subject matter included in this college level beginning electricity/electronics course?

yes _____

no _____

Comment:

3. Is the length of the test appropriate for testing retention and understanding of the subject matter?

yes _____

no _____

Comment:

4. Are all test items free of ambiguity?

yes _____

no _____

Comment:

5. Are the items free of bias toward a particular method of teaching?

yes _____

no _____

Comment:

Additional comments and suggestions are welcomed.

APPENDIX C

LETTER TO PROSPECTIVE JURY MEMBERS

LETTER TO PROSPECTIVE JURY MEMBERS

January 12, 1976

(Name)
Department
School
City, State Zip Code

Dear (Name):

I am in the process of designing a test instrument to be used in a research project as a part of the requirements for the doctoral degree in industrial education at Texas A&M University.

This test instrument will be used as both a pretest and posttest in a beginning college level electronics course at East Carolina University, Greenville, North Carolina. A comparison of test scores will be used to determine what effect student involvement with amateur radio has on achievement in electronics. Since you are experienced in the field of electronics, your opinions and suggestions concerning the test questions would be helpful in refining the test.

Realizing that you are busy with your own responsibilities, I will understand if you are unable to review the test instrument. I would appreciate your checking the appropriate block on the enclosed postal card to indicate whether or not you are willing to serve as a jury member to review the test and returning the card to me. Jury members will be recognized in my dissertation.

Sincerely,

Jerry V. Tester

APPENDIX D

POSTAL CARD FOR PROSPECTIVE JURY MEMBERS

POSTAL CARD FOR PROSPECTIVE JURY MEMBERS

I will serve as a jury member to review the
test instrument.

☐ Yes

☐ No

Signature _____

APPENDIX E

COVER LETTER FOR TEST INSTRUMENT EVALUATION

COVER LETTER FOR TEST INSTRUMENT EVALUATION

January 22, 1976

(Name)
Department
School
City, State, Zip Code

Dear (Name):

Thank you for taking time from a busy schedule to evaluate the enclosed test instrument.

The test is designed to evaluate the extent of achievement for the most advanced student; therefore, there are questions included which are not covered in the subject matter for the course. Approximately 75% of the items relate to subject matter covered in the beginning electricity/electronics course at East Carolina, and roughly 25% of the items cover more advanced subjects. The number of advanced items is divided proportionally among the three types of test items in the instrument.

Also enclosed is an evaluation form for your use in evaluating the test instrument. Please include comments in your response as your opinions are beneficial in instrument revision.

If it is possible, I would like to have the completed evaluation form by Tuesday, February 10, 1976. If your schedule does not permit your returning the form by this date, I would appreciate having it as soon thereafter as you can return it.

Your cooperation in this research project is appreciated.

Sincerely,

Jerry V. Tester

APPENDIX F

THE TEST INSTRUMENT

THE TEST INSTRUMENT

Electronics 270 Exam

Name _____

Multiple Choice

Directions: Each of the questions or incomplete statements listed below is followed by four possible answers. Select the one correct, or most nearly correct, answer and place the letter of that answer in the blank space provided at the left of the item number.

Example:

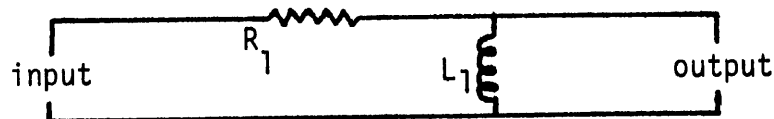
- B The president of the United States during the Civil War was
- | | |
|---------------------|----------------------|
| A. Thomas Jefferson | C. George Washington |
| B. Abraham Lincoln | D. Lyndon B. Johnson |
1. With four coulombs of electrons passing a given point in a circuit each second, the amount of current flow is
- | | |
|----------------------|----------------------|
| A. four milliamperes | C. forty amperes |
| B. four amperes | D. four microamperes |
2. The physical size of a resistor usually represents the
- | | |
|-----------------------------------|--------------------|
| A. resistance value | C. brand name |
| B. power dissipating capabilities | D. tolerance value |
3. A receiver draws .75 amperes while connected to a 120 volt line. The power being used is
- | | |
|----------|---------|
| A. 180 W | C. 45 W |
| B. 90 W | D. 75 W |
4. A meter which is connected in parallel to the circuit is the
- | | |
|--------------|----------------------|
| A. voltmeter | C. ammeter |
| B. SWR meter | D. moving iron meter |
5. The main factor which determines the strength of an electro-magnet is the
- | | |
|-----------------------|----------------------------|
| A. ampere-turns value | C. wire gauge |
| B. core material | D. type of wire insulation |

Multiple Choice, continued

- ___ 6. If the period of a sine wave is two milliseconds, the frequency is
- A. 1 KHz
B. 500 KHz
C. 100 Hz
D. 500 Hz
- ___ 7. Most AC voltmeters read voltage in terms of
- A. peak-to-peak values
B. RMS values
C. peak values
D. average values
- ___ 8. Which one of the following frequencies causes the greatest counter emf in an inductor?
- A. 100 Hz
B. 1 KHz
C. 45 KHz
D. 93.7 MHz
- ___ 9. The unit of measurement for capacitance is the
- A. Farad
B. Gilbert
C. Maxwell
D. Fleming
- ___ 10. In a purely capacitive circuit,
- A. I lags E by 90 degrees
B. E lags I by 90 degrees
C. I leads E by 180 degrees
D. E leads I by 180 degrees
- ___ 11. In a RLC circuit, the frequency which causes X_L to be equal to X_C is known as the
- A. avalanche frequency
B. saturation frequency
C. modulating frequency
D. resonant frequency
- ___ 12. A device which allows small voltage changes to cause large voltage changes is the
- A. oscillator
B. amplifier
C. rectifier
D. mixer
- ___ 13. In order to provide regenerative feedback, a tapped coil is used in the tank circuit of a/an
- A. Armstrong oscillator
B. Franklin oscillator
C. Colpitts oscillator
D. Hartley oscillator

Multiple Choice, continued

- ___14. There are basically two kinds of waves emitted from a transmitting antenna; these waves are
- A. transmitted and received waves
B. sky and ground waves
C. operational and message waves
D. sine and square waves
- ___15. The two main frequencies which are transmitted from an AM transmitter are the
- A. carrier and audio frequencies
B. audio and limiter frequencies
C. DC and modulation frequencies
D. sideband and carrier frequencies
- ___16. In stereo FM, what percentage of the total modulation is the main channel?
- A. 45%
B. 75%
C. 50%
D. 80%
- ___17. What is the name of antennas that are grounded at one end?
- A. Marconi
B. Hertz
C. Phase
D. Polarized
- ___18. The following circuit is a/an



- A. high pass filter
B. rectifier circuit
C. blanking filter
D. low pass filter
- ___19. The symbol  represents a/an
- A. AND gate
B. OR gate
C. flip-flop
D. binary to decimal converter
- ___20. A telephone receiver operates on the principle of
- A. magnetism
B. capacitance
C. chemical
D. resistance

Multiple Choice, continued

- ___21. The stage of a television transmitter that has the purpose of increasing the frequency of the modulated carrier is the
- A. mixer
B. multiplier
C. RF driver amplifier
D. audio modulator
- ___22. An electronic device used to convert some form of energy, such as light, sound, heat, etc., into voltage and current is called a/an
- A. input converter
B. processing unit
C. output converter
D. digital display unit
- ___23. The symbol  is a schematic representation of a/an
- A. antenna
B. speaker
C. display unit
D. transmitter
- ___24. The type of integrated circuit that has all elements formed in a single wafer of semiconductor material is the
- A. monosubstrate
B. monochip
C. monolithic
D. monowafer
- ___25. If the diameter of a conductor of given length is doubled, the value of resistance will be
- A. double the original
B. one-half of the original
C. one-fourth of the original
D. the same as the original
- ___26. The electron theory of current flow states that current flows from
- A. positive to negative
B. positive to positive
C. negative to negative
D. negative to positive
- ___27. A power company charges 7 cents per kwh. What is the cost of operating three 120 volt lamp bulbs connected in parallel for 24 hours if each bulb has an internal resistance of 100 ohms?
- A. 75.8¢
B. \$1.34
C. 72.6¢
D. 62.7¢
- ___28. That characteristic in a magnetic circuit which is analagous to voltage in an electrical circuit is
- A. field intensity
B. flux
C. magnetomotive force
D. permeability

Multiple Choice, continued

- ___ 29. If all that is specified is that AC is used in a circuit, the waveshape of the AC would be assumed to be a/an
- A. square wave
 - B. sine wave
 - C. sawtooth wave
 - D. triangular wave
- ___ 30. If the current in an inductor is changing at the rate of 500 milliamps per second, and a counter emf of two volts is produced, the coil is said to have inductance value of
- A. 4 Hy
 - B. 1 Hy
 - C. 2 Hy
 - D. 8 Hy
- ___ 31. The measure of how rapidly the current or voltage reaches its peak value in a RC circuit is described by the circuit's
- A. impedance
 - B. time constant
 - C. phase angle
 - D. capacitance value
- ___ 32. Which of the following combinations could be used to replace a 500 ufd capacitor?
- A. 200 ufd and 300 ufd connected in series
 - B. 200 ufd and 300 ufd connected in parallel
 - C. three 200 ufd connected in series
 - D. two 300 ufd and one 200 ufd connected in parallel
- ___ 33. As the result of a frequency change in a PLC circuit, the resistance value remains unchanged, X_L is doubled, and X_C is reduced to one-half the original value. The new frequency value will be
- A. double the original
 - B. one-half of the original
 - C. one-fourth the original
 - D. four times the original
- ___ 34. If the load resistance of an unregulated power supply is decreased, the ripple voltage would
- A. increase in amplitude
 - B. increase in frequency
 - C. decrease in amplitude
 - D. decrease in frequency
- ___ 35. That element of a vacuum tube which emits electrons is called the
- A. grid
 - B. plate
 - C. cathode
 - D. filament

Multiple Choice, continued

- ___36. In regard to radar units, the letters PRR represent
- | | |
|--------------------------|--------------------------|
| A. Pulse Radar Recovery | C. Pulse Repetition Rate |
| B. Pulse Reflection Rate | D. Pulse Recovery Ratio |
- ___37. What value of AF power is needed to sine-wave plate modulate a 50,000 watt AM transmitter to 100% modulation?
- | | |
|----------|------------|
| A. 25 Kw | C. 12.5 Kw |
| B. 50 Kw | D. 100 Kw |
- ___38. A dummy antenna is actually just a large
- | | |
|--------------|----------------|
| A. inductor | C. transformer |
| B. capacitor | D. resistor |
- ___39. Assuming all of the following types of antennas are of similar size, which type has greatest gain?
- | | |
|------------------------|---------------------|
| A. parabolic-reflector | C. corner-reflector |
| B. plane-reflector | D. long-wire |
- ___40. One S unit represents a gain of
- | | |
|---------|---------|
| A. 6 dB | C. 9 dB |
| B. 3 dB | D. 1 dB |
- ___41. In a television receiver, what is the horizontal sync frequency?
- | | |
|------------|---------------|
| A. 60 Hz | C. 15.750 KHz |
| B. 4.5 MHz | D. 525 KHz |
- ___42. The electron-moving force in a circuit that pushes and pulls electrons through the circuit is known as
- | | |
|------------------------|----------------|
| A. electromotive force | C. resistance |
| B. current | D. conductance |
- ___43. If an AC line has 117 volts (RMS) across it, the peak-to-peak value of the line voltage is
- | | |
|------------|------------|
| A. 330.9 V | C. 661.8 V |
| B. 165.4 V | D. 105.2 V |
- ___44. Electrical energy is transferred from the primary of a transformer to the secondary through the principle of
- | | |
|---------------|------------------|
| A. conduction | C. rectification |
| B. impedance | D. induction |

Multiple Choice, continued

- ___ 45. Of the following components, that one whose resistance value can be electrically varied is the
- | | |
|------------------|--------------------------------|
| A. rheostat | C. composition fixed resistors |
| B. potentiometer | D. transistors |

Completion

Directions: Complete the following statements by supplying the proper word(s) in the blank space provided.

Example:

The year 1976 is America's Bicentennial commemorating the adoption of the Declaration of Independence.

1. The rate at which electrical energy is converted into heat energy is known as _____.
2. The resistance value of a yellow-violet-brown (colors read from left to right) striped resistor is _____ ohms.
3. Current flow is usually large and uncontrolled in a/an _____ circuit.
4. The best solder to use in general electronics work should be _____ core solder.
5. A wattmeter is used to measure electric _____.
6. The oscilloscope control which determines the height of the image displayed on the oscilloscope is the _____ control.
7. The number of flux lines per unit area is known as flux _____.
8. The number of cycles per second of alternating current is known as _____.
9. The use of a laminated core in a transformer reduces the effect of _____ current losses.
10. That property of a circuit which opposes a change in voltage is known as _____.
11. The current flows opposite the direction in which the _____ points in a semiconductor diode symbol.

Completion, continued

12. In an effort to maintain a constant output voltage value, the _____ of a shunt type voltage regulator decreases as the output voltage increases.
13. The control grid bias of a vacuum tube amplifier is usually _____ (positive/negative) with respect to the cathode.
14. A/an _____ type transistor has a base of P-type material and the emitter and collector of N-type material.
15. A/an _____ circuit is used to generate an AC signal.
16. One electronic related hobby which may involve the use of radio teletype is that of _____.
17. The two transmission lines that are used for microwave frequencies are _____ and _____.
18. The purpose of the _____ amplifier in a transmitter is to increase the amplitude of the RF signal to the wattage requirements of the station.
19. The frequency spectrum for standard broadcast FM radio is from _____ to _____.
20. The _____ section of an AM superhetrodyne receiver determines the bandpass of the receiver.
21. The intermediate frequency of standard broadcast FM receivers is _____.
22. An electrical prime mover is called a/an _____.
23. In a commercial telephone system, a steady current flows through the circuit in periods of silence. This current is varied when sound waves strike the _____.
24. When a beam of electrons is moved back and forth horizontally and from top to bottom of the picture tube, this process is known as _____.
25. A cylinder-shaped coil with a movable core which can be used to move mechanically some device (for example, a switch) is called a/an _____.

Completion, continued

26. When varying currents are passed through the _____ of a speaker, magnetic forces are created which cause the diaphragm to vibrate.
27. The _____ of a copper conductor is greater for high frequency current than for low frequency current.
28. The value of voltage remains constant throughout a/an _____ resistive circuit.
29. If two AC voltages do not reach their peaks at the same time, they are said to be _____.
30. That component of a circuit that opposes any change in current is called _____.
31. The _____ of an amplifier can be determined by dividing the change in output voltage by the change in input voltage.
32. The most common biasing arrangement for class A transistor amplifiers is _____ bias.
33. What percent of the total radiated power from an AM transmitter with 100 percent modulation is in the sidebands? _____
34. The frequency range of standard broadcast AM radio is from _____ to _____.
35. When the _____ granules in a telephone microphone become more densely packed, more current flows.
36. The television video signal is _____ modulated.
37. If a composite television signal has a horizontal sync pulse peak level of 100 percent, the blanking level is _____ percent.
38. While the SCR anode is positive and the gate current is zero, nearly all of the applied voltage appears across the _____ junction.
39. The basic current formula for Ohm's Law is $I = \underline{\hspace{2cm}}$.
40. _____'s Law states that the amount of current entering a given point in a circuit is equal to the amount of current leaving that point.

Problems

Directions: Follow the instructions given with each of the problems listed below. Please show all work.

1. The output voltage of a DC power supply measures as follows: AC volts = 25 volts (RMS) and DC volts = 256 volts. Calculate the percent of ripple voltage in the output voltage of the power supply. Select the most nearly correct answer from those provided below and place the letter of that answer in the place provided.

A. 9%
B. 10%

C. 2%
D. 1%

Answer _____

2. Identify by name each of the following types of radio communications.

A1 _____

F3 _____

A3J _____

3. Calculate the length in meters of an antenna for 4 MHz if the antenna is one and one-half wavelengths long. Select the most nearly correct answer below and place the letter of that answer in the space provided.

A. 112.5 meters
B. 225 meters

C. 56.25 meters
D. 106.9 meters

Answer _____

Problems, continued

4. Please write the standard resistor color code for the following numbers:

0 _____

6 _____

2 _____

7 _____

4 _____

9 _____

5. Draw a block diagram of an AM radio and label each block.

Problems, continued

6. Draw the schematic diagram of a transistor audio amplifier stage with resistor bias. Show the circuit, placement of the input signal, and location of the output signal. (Note: Use a NPN transistor,)

7. Calculate the power input of a 2 Hp AC motor which has a power factor of 0.9 and is 80% efficient. Select the most nearly correct answer and place the letter of that answer in the space provided.

A. 2,072 w
B. 1,492 w

C. 1,776 w
D. 1,036 w

Answer _____

Problems, continued

8. If a transformer has 10,000 turns on the primary and 1,000 turns on the secondary, what is the primary voltage if the secondary voltage is 100 volts? If the load impedance is 1 ohm, calculate the primary current and the secondary current. Assume the transformer efficiency is 100%, and round-off your answer to the nearest tenth (For example, $9.34 = 9.3$ and $9.35 = 9.4$). Place your answer in the space provided.

primary voltage _____

primary current _____

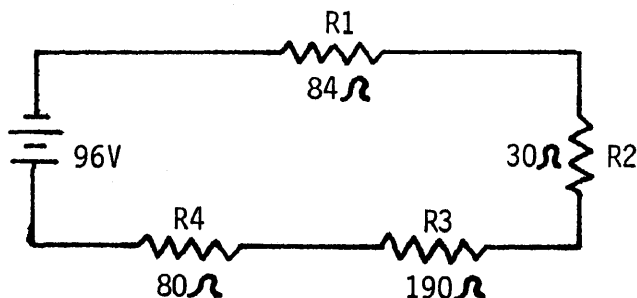
secondary current _____

9. Calculate the total resistance, total current, and the voltage across R_2 for the circuit shown below. Round off your answer to the nearest tenth, and place them in the blank provided.

$R_t =$ _____

$I_t =$ _____

$E_2 =$ _____



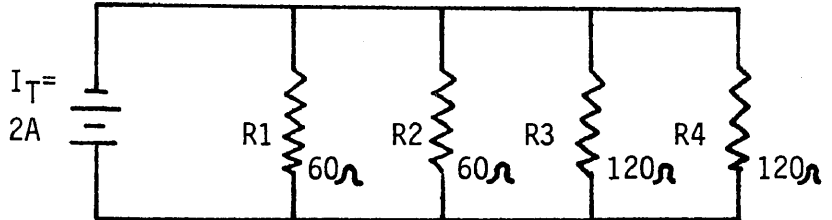
Problems, continued

10. Calculate the total resistance, applied voltage, and current in R_2 for the circuit below. Round off your answers to the nearest thousandth and place them in the space provided.

$R_t =$ _____

$E_A =$ _____

$I_2 =$ _____



11. Please make the following conversions:

500 ma = _____ amps

10 milliHy = _____ Hy

1 K volt = _____ volts

50 uamps = _____ ma

.01 ufd = _____ farads

2 Megaohms = _____ ohms

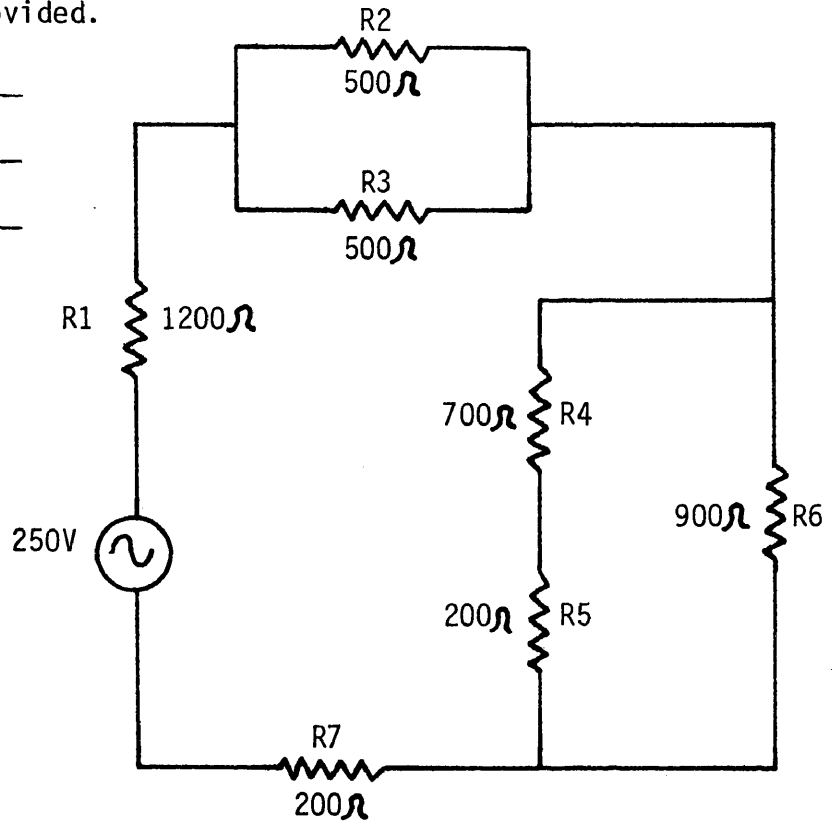
Problems, continued

12. Using the circuit shown below, calculate the total resistance, total current, and voltage across resistor number five. Round answers off to the nearest thousandth, and place answers in the blank provided.

$$R_t = \underline{\hspace{2cm}}$$

$$I_t = \underline{\hspace{2cm}}$$

$$E_5 = \underline{\hspace{2cm}}$$



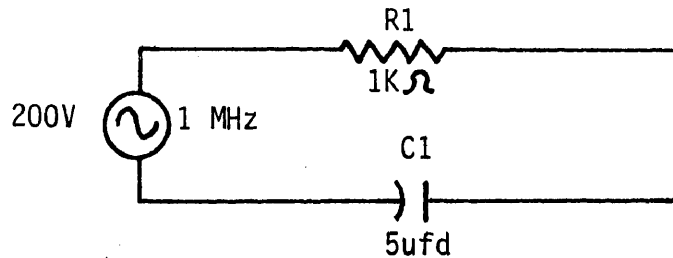
Problems, continued

13. Calculate the impedance, total current and the phase angle for the circuit shown below. Record answers in the blank provided, and round off answer values to the nearest one-thousandth. (Note: Use 3.1400 for π .)

$Z =$ _____

$I_t =$ _____

$\phi =$ _____

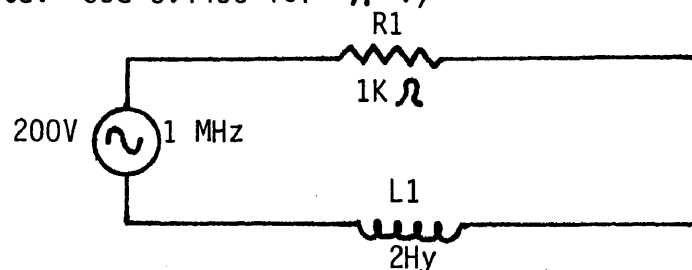


14. For the circuit shown below, calculate the impedance, total current, and the phase angle. Record answers in the blank provided, and round off answer values to the nearest one-thousandth. (Note: Use 3.1400 for π .)

$Z =$ _____

$I_t =$ _____

$\phi =$ _____



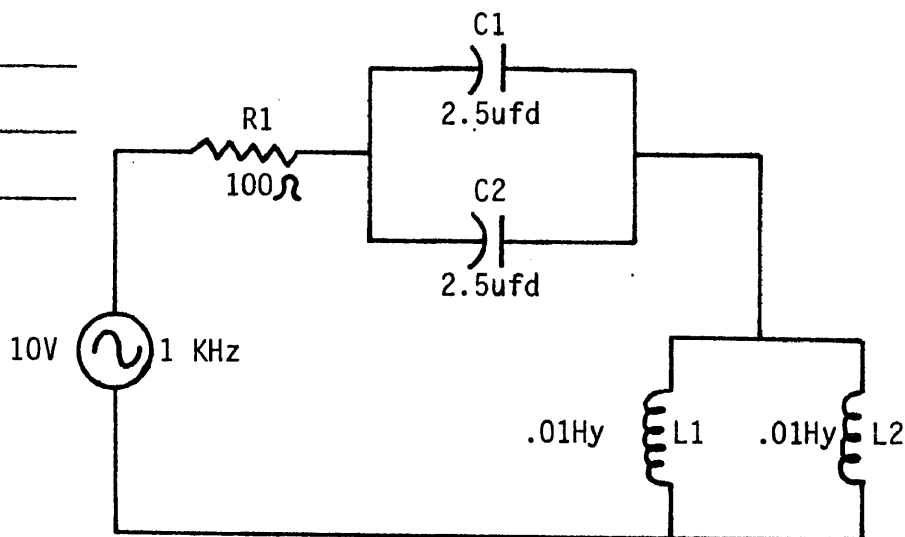
Problems, continued

15. Calculate the total capacitance, total inductance, and the impedance of the circuit shown below. Record answers in the blank provided, and round off answer values to the nearest one-thousandth.

$C_t =$ _____

$L_t =$ _____

$Z =$ _____



Problems, continued

16. At laboratory stations one, three, and six you will find a connected circuit. Go to one (but only one) of the stations and use a VOM to measure the total current value in the circuit. Record the measured value below.

$I_t =$ _____

17. A waveform is being presented on the oscilloscopes at laboratory stations two, four, and seven. Go to one (but only one) of the stations and determine the amplitude, frequency, and period of the signal shown on the oscilloscope. Record the values in the proper blanks below. Please do not adjust any of the controls on the oscilloscopes.

amplitude = _____

frequency = _____

period = _____

APPENDIX G

STUDENT QUESTIONNAIRE

STUDENT QUESTIONNAIRE

1. Name _____
2. Hometown _____
3. Age _____
4. Student classification _____
5. Major _____
6. Area of concentration _____
7. Grade point average _____
8. Are you married or single? _____
9. Have you served in the
armed forces? _____
10. Do you hold a part-time job? _____
11. If you have a part-time job,
approximately how many hours
per week do you work? _____
12. Please list any college physics courses you have taken and the
grade you received for each course?

COURSE	GRADE
_____	_____
_____	_____
_____	_____
_____	_____

13. Please list all college math courses you have taken and the grade you received for each course.

COURSE	GRADE
_____	_____
_____	_____
_____	_____
_____	_____

14. Please list all electricity or electronics courses you have taken in either high school or college.

COURSE	GRADE
_____	_____
_____	_____
_____	_____
_____	_____

15. What courses are you taking this quarter?

_____	_____
_____	_____
_____	_____
_____	_____

16. Please state your past work experiences, especially any relating directly with electricity or electronics.

17. Do you have (or have had) any of the following hobbies?

amateur radio yes _____ no _____

citizen's band radio yes _____ no _____

radio controlled airplanes yes _____ no _____

stereo systems yes _____ no _____

18. Please list your current hobbies.

APPENDIX H

ANALYSIS OF VARIANCE TABLES FOR STUDENT CHARACTERISTICS

ANALYSIS OF VARIANCE TABLES FOR STUDENT CHARACTERISTICS

Student Classification				
Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	30	15.41936	-----	3.08333*
Treatment	1	1.48186	1.48186	
Error	29	13.9375	0.48060	

Age				
Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	30	316.968	-----	1.97752*
Treatment	1	20.234	20.234	
Error	29	296.734	10.232	

Marital Status				
Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	30	3.48387	-----	4.6774**
Treatment	1	0.48387	0.48387	
Error	29	3.0	0.10345	

*not significant at the .05 level

**significant at the .05 level

Major				
Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	30	11.67742	----	0.49015*
Treatment	1	0.194086	0.194086	
Error	29	11.483334	0.395977	

Grade Point Average				
Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	30	6.47262	----	0.1053122*
Treatment	1	0.02342	0.02342	
Error	29	6.4492	0.22238	

Course Load				
Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	30	82.1936	----	0.2692481*
Treatment	1	0.7561	0.7561	
Error	29	81.4375	2.80819	

*not significant at the .05 level

Weekly Hours Worked in Part-time Job				
Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	30	3217.871	----	0.263501*
Treatment	1	28.937	28.937	
Error	29	3188.934	109.96324	

Students Served in Armed Forces				
Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	30	4.193549	----	1.918534*
Treatment	1	0.260215	0.260215	
Error	29	3.933334	0.135632	

Previous Physics Hours				
Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	30	541.871	----	1.6360595*
Treatment	1	28.9376	28.9376	
Error	29	512.9334	17.687358	

*not significant at the .05 level

Physics Grades				
Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	30	31.05542	----	1.5343357
Treatment	1	1.56052	1.56052	
Error	29	29.4949	1.0170655	

Previous Mathematics Hours				
Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	30	790.0000	----	0.119023*
Treatment	1	3.2291	3.2291	
Error	29	786.7709	27.130031	

Mathematics Grades				
Source	Degrees of Freedom	Sum of Squares	Mean Square	F
Total	30	27.79878	----	0.0724961*
Treatment	1	00.06932	0.06932	
Error	29	27.72942	0.9561882	

*not significant at the .05 level

APPENDIX I

AMATEUR RADIO STATION LOG

AMATEUR RADIO STATION LOG

Date	Station	Frequency (MHz)	Location
3-15-76	W9ZNT/4	7.200	Florida
3-15-76	LU3CF	14.300	Buenos Aires, Argentina
3-16-76	WA8K0Q	7.235	New Richmond, Ohio
3-16-76	WA20PL	7.235	New York City
3-16-76	K2EPT	7.235	Berganfield, N.J.
3-17-76	K2ZHF	7.225	Long Island, N.Y.
3-17-76	EA4QF	14.200	Modrego, Spain
3-17-76	V01LB	14.200	Newfoundland
3-17-76	DL9PT	14.200	Buchreit, Germany
3-17-76	W4HHQ	7.250	Knoxville, Tenn.
3-17-76	Wa4IMR	7.250	Jacksonville, Fla.
3-17-76	WB8WDO	7.250	Canton, Ohio
3-17-76	W2DFA	7.250	New York City (west)
3-17-76	WB4THN	7.264	Franklin, N.C.
3-17-76	WA30TE	7.264	Pittsburg, Penn.
3-18-76	WB3YI	7.215	Univ. of Pittsburg
3-19-76	WA2MWT	7.255	Ramsey, N.J.
3-19-76	W2SNI	7.220	Rochester, N.Y.
3-19-76	W8GHN	7.250	Saint Joseph, Mich.
3-23-76	VA6RD	14.280	Georgia, U.S.S.R.
3-23-76	WB5BAH	14.300	Houston, Texas
3-23-76	WB8HVV	14.300	Michigan

LOG, continued.

Date	Station	Frequency (MHz)	Location
3-23-76	A08KUV	14.300	Michigan
3-24-76	W8GHN	7.256	Saint Joseph, Mich.
3-24-76	WA4MOK	7.257	Winterville, N.C.
3-24-76	WA8WME	7.240	Detroit, Mich.
3-24-76	WB2MDA	7.235	Patterson, N.J.
3-24-76	W2GWT	7.230	western New York
3-24-76	W2JIA	7.230	Long Island, N.Y.
3-24-76	WB2IWH	7.230	Clifton, N.J.
3-24-76	WA4ITS	7.245	Oxford, Ala.
3-24-76	DK4EB	14.330	Hoesel, Germany
3-26-76	W1CZ/m	7.230	St. Augustine, Fla.
3-26-76	K8GOE	7.250	Columbus, Ohio
3-29-76	WB4JDT/m	7.250	ship off east Africa
3-29-76	WB1PLT	14.311	Colorado Springs, Col.
3-30-76	WA2KNT	7.200	Syracuse, N.Y.
3-31-76	WB8ORD	7.200	Lima, Ohio
3-31-76	WB4ESO	7.275	Marietta, Georgia
4-1-76	WA4EOS	7.240	Lexington, Kentucky
4-1-76	W2CUF	7.240	Long Island, N.Y.
4-1-76	WB4AWQ	7.250	Orlando, Florida
4-1-76	W4JS	7.255	Rawlins Rapids, Georgia

LOG, continued.

Date	Station	Frequency (MHz)	Location
4-6-76	WA2SMM	7.205	Elmira, New York
4-6-76	W4NY	7.205	Florida (mobile)
4-6-76	WOWMJ	7.200	Raytown, Missouri
4-6-76	K5USA	14.302	Fort Sill, Oklahoma
4-6-76	K4ADB	7.255	Rockledge, Fla.
4-6-76	WB8MTR/4	7.244	Silver Springa, Fla.
4-7-76	EL8F	14.250	Liberia, Africa
4-8-76	WA2JBM	7.250	Rochester, N.Y.
4-8-76	WA5TNI	7.296	Austin, Texas
4-8-76	WB5LPT	7.292	Oklahoma City, Ok.
4-9-76	WA2TQT	7.265	Long Island, N.Y.
4-9-76	WA2UAY/2	7.265	Baldwinsville, N.Y.
4-16-76	K8GDE	7.200	Columbus, Ohio
4-16-76	WA1IXU	7.298	Waterburn, Conn.
4-16-76	W4JYX	7.248	Jeffersontown, Ky.
4-16-76	K4PUZ	7.248	Nashville, Tenn.
5-3-76	K4FROY	7.250	Gaston, Alabama
5-3-76	W1TLZ	7.240	Connecticut
5-7-76	W9LKO	7.250	Kokomo, Indiana
5-10-76	W8BDR	7.268	Westland, Michigan

LOG, continued

Date	Station	Frequency (MHz)	Location
5-10-76	K2UHK	7.268	New York
5-10-76	WA4BYA	14.250	Greenville, N.C.
5-12-76	WB8ORN/8	7.200	Beechwood, Ohio
5-14-76	WB4NMA	7.250	Fort Wentworth, Ga.
5-14-76	K5GBL	14.321	Harlingen, Texas
5-19-76	G4DFE	14.272	Dudley, England

Note: All contacts were made by radio amateur WB4EJQ/4 using 200 watts input power single-sideband (A3J) transmission.

APPENDIX J

EXPERIMENTAL GROUP TEST SCORES

EXPERIMENTAL GROUP TEST SCORES

Student	Pretest Score	Posttest Score	Pre-Posttest Difference
1	28.45	67.30	38.85
2	24.14	53.15	29.01
3	14.90	51.50	36.60
4	14.75	54.95	40.20
5	14.70	51.80	37.10
6	14.25	54.95	40.70
7	13.85	50.10	36.25
8	13.15	54.30	41.15
9	12.30	63.60	51.30
10	11.65	62.20	50.55
11	10.10	69.90	59.80
12	9.95	48.60	38.65
13	9.55	52.00	42.45
14	8.55	49.00	40.45
15	7.75	58.40	50.65
16	4.90	61.60	56.70

APPENDIX K

CONTROL GROUP TEST SCORES

CONTROL GROUP TEST SCORES

Student	Pretest Score	Posttest Score	Pre-Posttest Difference
1	49.96	69.35	19.39
2	46.35	75.60	29.25
3	18.10	57.60	39.50
4	17.60	48.70	31.10
5	16.90	44.90	28.00
6	15.95	65.40	49.45
7	15.45	26.35	10.90
8	15.05	52.95	37.90
9	14.30	54.95	40.65
10	11.70	63.75	52.05
11	8.60	47.70	39.10
12	8.55	65.60	57.05
13	7.05	68.60	61.55
14	2.55	50.40	47.85
15	1.00	58.35	57.35